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J Black.

Mechanick Dialling;

OR, THE

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without the Fatigue of going through a Courſe of Mathematics.

A NEW EDITION: not only very much improved by the Addition of the NEW STAR-DIAL, *&c.* but is the only Book upon the Subject that has been adapted to the NEW STILE.

By Mr. CHARLES LEADBETTER.

LONDON:
Printed for G. PEARCH, at No. 12, in Cheapſide. 1769.

PREFACE.

SEEING the Buſineſs of Dialling, if Mechanically *conſidered, is of itſelf a Thing ſo* natural *and* eaſy, *one would wonder, after ſo much* learned *Buſtle as the* Mathematicians *have made about it, that they ſhould have more* perplexed *and* obſcured *than promoted the Knowledge of that* uſeful *and* entertaining *Art amongst the* Generality *of Mankind.*

The different Ways, *in which theſe Gentlemen have* hitherto *choſe the World ſhould ſee that* uſeful *Subject handled, would certainly have been right and proper, and liable to no Exception, if* all Men *were* Mathematicians: *But how few are ſuch? And therefore their having treated of Dialling in a* Geometrical, Inſtrumental *or* Arithmetical *Method, I am ſure cannot poſſibly be of any* Uſe *or* Signification *to ſuch as know nothing at all of thoſe Sciences, or the* Doctrine of the Sphere.

Certainly, *there are* two *very different Ends of writing Books, which treat of any Art or Science; the one is to advance the Art or Science itſelf, and the* other *to* inſtruct Learners.

Now, with reſpect to the Former, *the* Extent *and* Capaciouſneſs *of the Subject is chiefly to be regarded; and nothing is to be omitted which properly falls within the Compaſs of the Art or Science treated of; but with reſpect to the* latter, *the* Capacities *of the* Learners *are principally to be conſidered, and Notice is to be taken, not of whatever may be known or done by the Art or Science treated* *of, but only of what is* moſt uſeful, *and withal* moſt eaſy *to be known.*

The moſt proper *and* rational *Method, therefore, to make any one Maſter of any Art or Science, is to introduce it to him after the moſt* plain, familiar *and* natural *Method, and to teach him at* firſt *only ſo much of the Art as is really uſeful in* common Life, *and withal moſt eaſy to be underſtood; and when he has gone through, and is become Maſter of what is moſt* uſeful *and* eaſy, *he will be enabled with more Eaſe to conquer the more* difficult *Parts of it, and to purſue the Study of it after a more* learned *Manner, if his own* Inclinations *or* Profeſſion *ſhall incline him ſo to do.*

Upon theſe Conſiderations, and with this View it was that I drew up this Treatiſe of Mechanick Dialling, *becauſe of all thoſe who have hitherto treated upon this Subject in the* Engliſh Tongue *for the* Inſtruction of Learners, *not one of them ſeems to me to have* thoroughly conſidered *what I have now premiſed.*

By the Method *I have obſerved in this Treatiſe, the* Length *and* Dryneſs *of the Study of* Dialling *(which has diſcouraged many) is quite removed; and it is now rendered not only* very uſeful, *but* perfectly eaſy *and* entertaining: *And I think without Vanity I may venture to affirm, that by the Help of this Book only, the* Learner *may obtain a competent Knowledge in Dialling, in much leſs* Time, *and with* much leſs Trouble, *than he can by the Aſſiſtance of* any other, *or indeed* all *the Treatiſes which have yet appeared in* Engliſh *upon this Subject: where he will either find the* eaſy and uſeful, *and the* difficult and uſeleſs *Elements of this Art* promiſcuouſly *and* injudiciouſly *exhibited* *and taught* together; *or elſe the Subject treated of after ſuch a Manner* as can never be comprehended *by any one that does not underſtand ſome of the* abſtruſeſt Branches *of the* Mathematics.* *But*

It is high Time that I ſhould now proceed to give the Reader the Particulars of what he may expect to meet with in the following Treatiſe.

In the firſt Place, *he is made Maſter of thoſe few* Geometrical Problems, *which may be of Service to him in* Mechanick Dialling.

Secondly, *I have taught him not only the* Uſe *of the* Quadrant *and* Trigon, *but alſo how to make thoſe* univerſal *Inſtruments, which for their* Simplicity, *and the great Uſe they are of in Dialling are never enough to be valued. I have likewiſe taught him not only the* Uſe *of, but alſo how to make* Dialling Scales, *and this is not to be met with in any other Treatiſe extant upon this Subject.*

Thirdly, *I have given him ſuch* plain *and* ample *Directions, that it will be impoſſible for him to miſcarry in making of a Dial for* any Place in the World, *whether the Dial be* Equinoctial, Horizontal, Erect, Declining, Reclining *or* Inclining.

Fourthly, *to theſe I have added* plain *and* eaſy *Directions for making of* Reflective, Refractive *and* Globe Dials.

I have likewiſe taught the Reader how to make a Croſs Dial, *and in this, on account of its* Novelty, *I have been very full and particular, not only in ſhewing him after what Manner it muſt be made, but in having the ſeveral* neceſſary *Views or Poſitions of it engraved on Copper. I was tempted to be thus particular, by reaſon I never yet ſaw*

---

* *Such as* Geometry, Aſtronomy, *&c.*

or heard that there was any other Dial of that Sort in England, *beſides that which I have mentioned in this Treatiſe. And I have alſo in this* new Edition *given a* Copper-plate *of, as well as Directions for making the* new invented STAR-DIAL.

Fifthly, *I have furniſhed the Reader with the following very uſeful and accurate Tables, all adapted to the* new Stile.

1. *A Table of the* Sun's Declination, *exactly calculated for the Year* 1764, *and which (for the Uſe of Dialling) will ſerve for this Age without any* ſenſible *Error.*

2. *An* exact *Table of the* Equation of Time *for the Regulating of* Clocks *and* Watches *by a* Sun Dial.

3. *A Table for the converting of* Hours *and* Minutes of Time *into* Degrees and Minutes of the Equinoctial, *and* è contra.

4. *A Table for drawing the* Hour Lines *upon all* Horizontal, *&c.* Dials, *from the* Equinoctial *to the* Poles.

5. *A Table of the* Three Requiſites *in Dialling, ſhewing the* Subſtile's Diſtance *from the* 12 a-clock Hour Line; *the* Stile's Height; *and the* Inclination of Meridians *anſwering to the ſeveral Degrees of the* Declination of your Plane.

6. *A Table ſhewing the* Sun's Altitude *for every* Hour and Quarter of the Day, *at his* Entrance *into the* 12 Signs *of the* Zodiack.

Sixthly, *I have given a* plain *and* familiar *Deſcription of the* Sphere, *for the Sake of ſuch as are inclined to have a true Notion of ſuch* Circles in the Heavens, *as are frequently mentioned in* this *and* other Books *of Dialling.*

Seventhly, *In* Chap. XXIII. *is a Collection of*

Mottos *for Dials in* Latin *and* Engliſh, *ſuitable to almoſt all Places where Dials may be fixed.*

Eighthly, *That nothing may be wanting to render this Work compleat, I have added a* new *and* correct *Alphabetical Table of the moſt eminent* Cities, Towns, *&c. in the whole World, ſhewing at* each Place *the* Elevation of the Pole *and* Difference of their Meridian *from* London, *and this Table may be depended upon to be the* beſt that is extant, *becauſe I have ſpared neither Time nor Pains to correct as many as I could from* celeſtial Obſervations.

Ninthly, *In* Chap. XXVI. *I have been very full and particular concerning the Manner of* making *and* painting *of* Dial Planes, *and alſo concerning the preparing the different* Colours *and* Oils *proper for that Purpoſe; and in this I hope to merit the Approbation of thoſe who live in the Country, and cannot upon all Occaſions have the Aſſiſtance of a profeſſed Painter.*

And I have alſo added Chap. XXVII. *concerning* Painting Houſes, &c. *being thoroughly convinced that all thoſe* Country Gentlemen, *and* others, *who are inclined to be* good Huſbands, *will think it very well worth their Peruſal.*

Laſtly, *Though it may appear a little foreign to my preſent Purpoſe, yet for the Entertainment of the curious, I have ſhewn (in* Chap. XXV.) *how* naturally *the* two *Hands of a* Watch *or* Clock *repreſent the* Motions *of the* Sun *and* Moon.

And now wiſhing my Reader as much Benefit *from the Peruſal of this Treatiſe, as I have had* Pleaſure *in compoſing of it, I remain his faithful Friend whilſt*

CHARLES LEADBETTER.

CONTENTS.

Page

CHAP. I. *Of Things neceſſary to be known by the Mechanick Dial-Maker* - 1

Viz. *To divide a* right Line *into* two *equal Parts* 2

To raiſe a Perpendicular *on the middle of a* right Line - - - - - - - - - - - 3

To let fall a Perpendicular *upon a* right Line *from a given Point* above - - - - - - - 3

To raiſe a Perpendicular *at the* End *of a Line given* 4

To draw Lines parellel *to each other* - - - 4

To draw Parellel *or* Concentric *Circles* - - 5

To find a loſt *Center* - - - - - - - - 5

Three Points *not in a* right Line *given to make a* Geometric Square - - - - - - - 6

To make a Line of Chords *to any* Length *or* Radius 6

To make a Line *or* Scale of Six Hours - - 7

To make a Line *or* Scale of Inclination of Meridians 7

To make a Line *or* Scale of Latitudes - - 8

To make a Quadrant - - - - - - - - 8

To make a Trigon [See alſo Page 92] - - 10

CHAP. II. *Of* Dialling *in general* - - 12

A new *and* correct *Table of the principal* Cities *and* Towns *in* England, Scotland, Ireland *and* Wales, *ſhewing at each Place the* Elevation of the Pole, *and* Difference of their Meridian *from* London: *which has been compared with* Mr. NEALE's - - - - - - - - - 13

CHAP. III. *To make an* Equinoctial *Dial* - 15

Page
CHAP. IV. *To make an* Horizontal *Dial* - 18
CHAP. V. *To make an erect direct* South *Dial* 20
CHAP. VI. *To make an erect direct* North *Dial* 23
CHAP. VII. *To make an erect direct* Eaſt *Dial* 25
CHAP. VIII. *To make an erect direct* Weſt *Dial* 27
CHAP. IX. *To make a* Polar *Dial* - - - 28
CHAP. X. *To find the* Declination of a Wall *or* Plane *whereon to draw or fix a* Sun Dial - 30
CHAP. XI. *To make an erect* Declining *Dial* 31
CHAP. XII. *To make a* Dial *upon a* Plane *where the* Pole *has but ſmall Elevation* - - 36
CHAP. XIII. *To make a Declining* Reclining *Dial* 39
CHAP. XIV. *To make an* Eaſt or *Weſt* Recliner 44
CHAP. XV. *To make a* North *or* South *Declining* Reclining *or* Inclining *Dial* - - 49
CHAP. XVI. *To make a* REFLECTIVE *Dial that ſhall give the true Hour of the Day where the* Sun cannot *ſhine* - - - - - - 52
CHAP. XVII. *To make a* REFRACTED *Dial* 57
CHAP. XVIII. *To make a* GLOBE *Dial* - 58
CHAP. XIX. *To make a* CROSS *Dial* - - 60
To make the new invented STAR *Dial* - - 63
To make a Window *Dial* - - - - - 66
A Table of the Sun's Declination - - - 68
A Table of the Equation of Time *for* Regulating *Clocks and Watches by the Sun* - - - 72

Page

A Table for converting Hours *and* Minutes *of Time into* Degrees *and* Minutes *of the* Equinoctial, *and for turning of* Degrees *and* Minutes *of the* Equinoctial *into* Hours *and* Minutes *of* Time - - - - - - - - 75

A Table ſhewing the Degrees of each Hour Line, *from* 12 a-clock, *upon all Horizontal and* North *and* South *Erect Direct* Reclining *and* Inclining *Dials, from the* Equinoctial *to the* Poles - - - - - - - - - - - 77

A Table of the Three Requiſites *in Dialling, ſhewing the* Subſtile's Diſtance *from the* Meridian; *the* Stile's Height; *and the* Inclination of Meridians; *anſwerable to the ſeveral* Degrees of Declination *of your* Plane - - - - - 82

A Table ſhewing the Sun's Altitude *every* Hour and Quarter *of the Day at his Entrance into the* 12 *Signs of the* Zodiack. - - - - 87

CHAP. XX. *Shewing the Uſe of the* Scales *in Plate* 2. viz. *The Line of* Chords; *the Scale of* Latitudes; *the Scale of* Six Hours, *and the Scale of* Inclination of Meridians - - - 89

Examples of Dials made by the Dialling Scales 89

The Uſe of the Trigon [See alſo Page 10] - 92

CHAP. XXI. *A Review of the* Equinoctial, *and Direct* Eaſt *and* Weſt *Dials* - - - 95

CHAP. XXII. *A Deſcription of the* Sphere 97

CHAP. XXIII. *A Collection of* above 300 Mottos *for Dials in* Latin *and* Engliſh 101

Page

CHAP. XXIV. *A* new *and* correct *Alphabetical Table of the moſt eminent* Cities, Towns, *&c. in the World, ſhewing at each Place the* Elevation of the Pole, *and the* Difference of their Meridian *from* London - - - 117

CHAP. XXV. *Concerning the* Motion *of the* two *Hands of a Watch or Clock as it repreſents the Motion of the* Sun *and* Moon - 125

CHAP. XXVI. *Of Painting* Sun Dials, *and of* making *the Planes or Surfaces upon which they are to be drawn* - - - - - - 128

CHAP. XXVII. *Of the Manner of Painting* Timber Work, *&c.* - - - - - - 142

N. B. *The DIALS for the* following *Places are to be found upon the* oppoſite *Pages.*

Cambridge - -	39
Cheſter - - -	21
Conſtantinople -	91
Cronton - - -	32
Durham - - -	18
Dublin - - -	59
Edinburgh - -	49
Exeter - - -	27
Liverpool - -	32
Lincoln - - -	40
London -	36 & 88
Norwich - - -	41
Newcaſtle - -	41
Ormſkirk - -	54
Oxford - - -	26
Port Royal - -	91
Penzance - -	90
Shrewſbury - -	43
St. Thomas Iſland	28
Worceſter - -	46
Warrington - -	32
Wrexham - -	42
York - - - -	24

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Mechanick Dialling.

CHAP. I. *Treats of Things neceſſary to be known by the Mechanick Dial-Maker.*

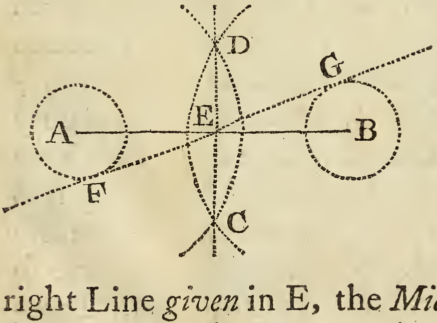
DIALLING originally is a *mathematical Science*, attained by the philoſophical Contemplation of the Motion of *the Sun*, the Motion of *the Shadow*, the *Conſtitution* of the *Sphere*, the *Situation* of *Planes*, and the *Conſideration* of *Lines*.

EXPLANATION. The *Motion* of the *Sun* is regular, it moving equal *Space* in equal *Time*; but the *Motion* of the *Shadow* irregular in all Parts of the Earth, unleſs *under* the two *Poles*, and that more or leſs, according to the Conſtitution of the *Sphere*, and Situation of the *Plane*: And therefore *ſcientific* Dialiſts, by the geometric Conſideration of Lines, have found out Rules to mark out the *irregular* Motion of the *Shadow* in all *Latitudes*, and on all *Planes*, to comply with the *regular* Motion of the Sun.

But though we may juſtly account *Dialling* originally a *Science*, yet ſuch hath been the Generoſity of many of its ſtudious Contemplators, that they have communicated their acquired Rules, whereby it is now become, to many of the Ingenious, no more difficult than an *Art*, and, by many late Authors, ſo intituled; nay more, by Means of this ſmall Treatiſe, it will ſcarce be accounted more than a *manual Operation*; for though the Authors I have met with ſeem to preſuppoſe their Reader to underſtand *Geometry*, and the *projecting of the Sphere* already, or elſe endeavour in their Works to make him underſtand them, as if they were abſolute neceſſary to be known by every one that would make a Dial, when as in Truth, the contemplative Pains of others afore≈ſaid conſidered, they are not; but, indeed, are only uſeful to thoſe that would know the *Reaſon* of *Dialling*. Thus they not only diſcourage young Beginners, but alſo diſappoint many Getlemen and others, that would willingly either make them themſelves, or ſet their Workmen about them, if they knew how to make them. The following Pages I have therefore compoſed, for the Help of thoſe who underſtand neither the *Projection of the Sphere*, or *geometrical Operations*.

PROB. I. *To divide a* right Line *given* (*as* A B) *into* two *equal Parts*.

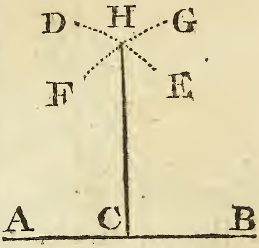
Open your Compaſſes to any Extent *more* than *half* the *Length* of the Line A B; ſet one Foot in A, and deſcribe the *Arch* DC, then, with the *ſame Extent* of the Compaſſes, ſet one Foot at B, and deſcribe the *Arch* D C on the other Side; where theſe two Arches *croſs* each other, lay a Ruler, and draw the *right Line* D C, and it will divide the right Line *given* in E, the *Middle* thereof. Or the ſame given right Line may be divided into *two equal Parts*, by ſetting one Foot of the Compaſſes on the *End* of the Line at A, and there deſcribe the dotted Circle, and then, with the *ſame Extent* of the Compaſſes, draw the *other* dotted Circle at B; laſtly, draw the right Line F G, and it will divide the given right Line AB in E, as before.



PROB.

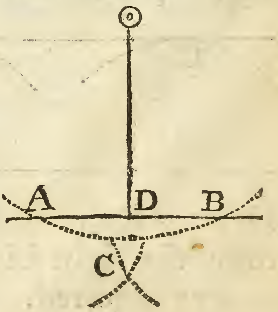
PROB. II. *To* erect *or* raiſe *a* Perpendicular, *on the* Middle *of a given* right Line.

N. B. *One Line is ſaid to be* perpendicular *to another, when it cuts it at right Angles, that is, makes a true Square.*



On the *End* of the given Line at A, ſet *one Foot* of the Compaſſes, and open the *other* to *any Extent*, more than *half* the *Length* of the Line, and deſcribe the Arch D E; with the *ſame Extent* ſet *one Foot* of the Compaſſes at B, and draw the Arch F G; lay a Ruler to C, *the Middle* of the given Line, and to the *Croſſing* of the *two Arches*, and draw C H, which will be *perpendicular* to A B, as was required.

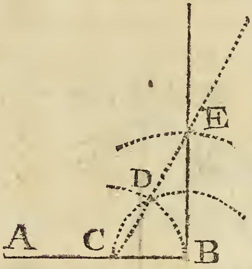
PROB. III. *To let* fall *a* Perpendicular, as ⊙ D *upon a right Line, from a given Point above.*



Let *the Point above* be ⊙, and the given right Line A B; ſet one Foot of your Compaſſes in ⊙, and extend the other Foot to A, and deſcribe the Arch A B; ſet one Foot of the Compaſſes in A, where the Arch cuts the given Line, and draw an Arch at C, with the *ſame* Extent; then ſet one Foot in B, *viz.* where the Arch cuts the Line, and draw another little Arch at C; lay a Ruler to the given Point ⊙, and to the *Croſſing* of the two little Arches at C, and draw the Line ⊙ D, ſo it will be at right Angles to A B, as was required.

PROB. IV. *To erect a* Perpendicular *at the* End *of a given Line.*

Let the given right Line be AB, and from the End B, let it be required to *erect a Perpendicular*, as BE.

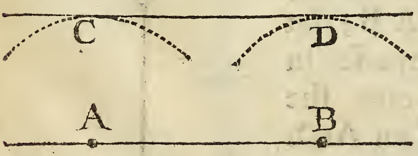


Open your Compaſſes to any convenient Diſtance, as B C, and draw the Arch C D; lay a Ruler to C and D, and draw the dotted Line CDE, as long as you pleaſe; take the Diſtance C D in your Compaſſes, and ſet from D to E, where you may, if you pleaſe, ſtrike an Arch, and where it cuts the Line CE, which is in E, there lay a Ruler to B, and draw BE, which ſhall be *perpendicular* to AB, *as was required.*

PROB. V. *To draw Lines* parallel *to each other.*

Parallel Lines are thoſe that being continued ever ſo far will never meet.

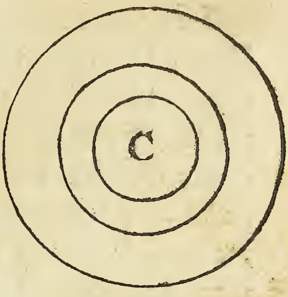
Let the Line given be AB, unto which I would draw a parallel Line. Open your Compaſſes to any *convenient* Diſtance, and ſet one Foot in A, draw an Arch at C, and carry *this* Extent to B, then draw the Arch at D, lay a Ruler to touch the Arches C and D, and draw the right Line CD, which is parallel to AB, as was required.



N. B. There is a Ruler ſold at the Mathematical Inſtrument-Makers, which greatly ſupplies the Uſe of this Problem, known by the Name of the *Parallel Ruler*, which I recommend to all my Readers as very uſeful.

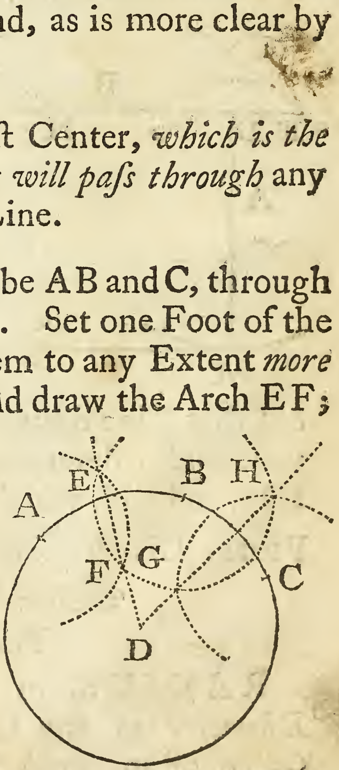
PROB. VI. *To draw* parallel *or* concentric *Circles.*

The Word *concentric* ſignifies having *the ſame* Center, and ſeveral Circles drawn from the ſame Center are ſaid to be *concentric:* therefore ſet one Foot of your Compaſſes in C the *Center*, and open the other Foot to the Diſtance of your Circle intended, and draw a Circle; keep the Foot of your Compaſſes in the ſame Center, and open the other to the diſtance of *another* Circle, which draw, and do ſo by as many as you intend, as is more clear by the Figure.



PROB. VII. *To find a* loſt Center, *which is the* ſame *as to find a* Center *that will paſs through* any three Points *not in a* right Line.

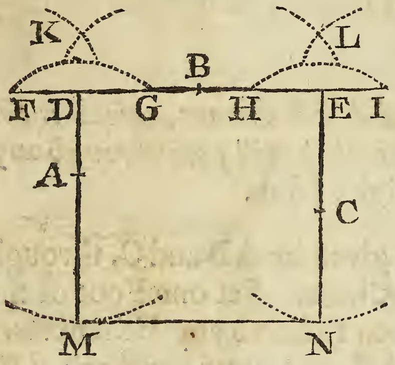
Let the *three* Points given be A B and C, through which I would draw a Circle. Set one Foot of the Compaſſes at A, and open them to any Extent *more than half* the Diſtance A B, and draw the Arch E F; carry the *ſame Extent* of the Compaſſes, and ſet one Foot in B; draw the Arch EGH, with the *ſame* Extent; ſet one Foot in C, and draw the Arch H G; lay a Ruler to E F, and draw the Line E D continued at Pleaſure; lay a Ruler to HG, and draw the Line HD, and it will meet with ED, in D *the Center* of the Circle, from



which Center draw a Circle with the Diſtance D A, and it will paſs through the three given Points A B C, as was required.

PROB. VIII. Three Points, *not in a* right Line *given to make a* geometric Square.

Let the *three Points* given be A B C; thro' the Point B draw the Line F I, ſet one Foot of the Compaſſes in the Point A, and draw the Arch F G; ſet one Foot of the Compaſſes in the Point C, and draw the Arch H I; ſet one Foot of the Compaſſes in H and I *ſeverally*, and draw the two Arches at L; ſet one Foot in F and G *ſeverally*, and draw the two Arches at K; lay a Ruler to L and C, and draw a Line *with the Point of your Compaſſes*; lay a Ruler to K and A, and draw another Line *with the Point of your Compaſſes*; then take DE in your Compaſſes, and ſet one Foot thereof in D and E *ſeverally*, and draw the Arches at M and N, and where thoſe Arches *cut* that Line drawn with the *Point* of your Compaſſes, *that* determinates the Length of the Lines DM, and EN, which draw *with Ink*, and it is done.



PROB. IX. *To make a* Line of Chords *to any aſſigned* Radius *or* Length.

Plate 2. Fig. 1.

RADIUS, in Geometry, ſignifies *half* the *Diameter* of any Circle *equal* to C B; and the *Chord* of an *Arch* is like the String of a Bow, *i. e.* it is a Line drawn from *any Point* in the Circumference of a Circle, to *any other Poiut* in the ſame Circle, as the Lines B 10, B 20, B 30, B 40, B 50, B 60, B 70, B 80, B 90, are the Chords of their reſpective Arches.

Firſt, draw the *Quadrant* BC 90, and divide the Arch into 90 *equal* Parts, which number with 10, 20, 30, *&c.* to 90 *Deg.* ſet one Foot of your Compaſſes in B, and draw the Arch 90 A 90, ſo ſhall the Line A B be the *Chord* of 90, to the *Radius* C B; becauſe all the *Chords* in the *Arch* B, 10, 20 and 90, are carried into the ſtreight Line A B; ſet one Foot of the Compaſſes again in B, and carry the *Degrees* in the *Arch* into the *Line* A B, and number them with 10, 20, 30, *&c.* from B to 90 at A, ſo ſhall you have a *Line of Chords*, and thus may you make one of what Length you pleaſe.

Prob. X. *To draw a Line, or Scale, of* ſix Hours.

Plate 2. Fig. 2.

With any *convenient* Opening of the Compaſſes, draw the *Quadrant* ABC, divide the *Arch* into *ſix* equal Parts, and draw the *Chord* AC; lay a Ruler to the *Center* B, and to *every* Diviſion in the Arch, and it will divide the *Chord* AC into a Scale of ſix Hours. See the Figure.

Prob. XI. *To make a Scale of* Inclination of Meridians.

Plate 2. Fig 3.

With the ſame *Radius*, or Opening of the Compaſſes, that you drew the *Quadrant* of the Scale of the ſix Hours, draw the *Quadrant* A B C; divide the Arch into *nine* equal Parts, and every one of them into *ten*, ſo will the *Quadrant* be divided into 90 equal Parts, or Degrees; then draw the *Chord*

AC; lay a Ruler to the *Center* B, and to *every* Diviſion in the Arch, and it will divide the *Chord* AC into a *Scale of Inclination of Meridians, equal* to that of the *Scale of ſix Hours.*

Prob. XII. *To make a* Line *or* Scale *of* Latitudes.

Plate 2. Fig. 4.

To proportion this Scale to the *other two* laſt mentioned, *the Scale of Latitudes* muſt be the *Chord* of 60 *Deg.* to the *ſame Circle,* in which the *Scale of ſix Hours* is the *Chord* of 90 *Deg.*

In either of the Problems X or XI, ſet one Foot of the Compaſſes in B, and take the *neareſt* Diſtance to the *Chord* AC, with *that* Extent draw the *Semicircle* DIF, and divide the *Quadrant* DI into 90 *equal Parts* or *Degrees,* and number them with 10, 20, 30, *&c* to 90; then, by *Prob.* V. or rather with your *Parallel Ruler,* draw the Lines 10*a*, 20*c*, 30*e*, *&c. parallel* to DE; lay a Ruler to D, and to *a, c, e, g, i, l, p,* and I *ſeverally,* and draw D*ab*, D*cd*, D*ef*, D*gh*, D*ik*, D*lm*, D*no*, D*pq*, and DI, and ſetting one Foot of the Compaſſes in F, *carry* the Points *b, d, f, h, k, m, o, q,* and I, into the Line FG, and number it with 10, 20, 30, 40, 50, 60, 70, 80, 90, which ſhall be a *Line of Latitudes* to the *given Radius.* Laſtly, *carry* the Points 10, 20, 30, 40, 50, 60, 70, 80, 90, in the Arch DI, into the Line DH, and that ſhall be a *Line of Chords,* anſwering the *Line of Latitudes, Inclination of Meridian* and *Hours.*

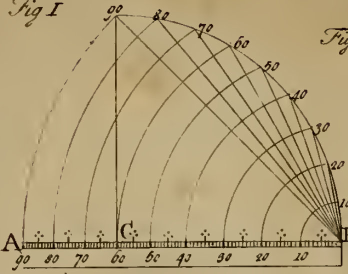
Prob. XIII. *To make a* Quadrant.

A QUADRANT is a very uſeful Inſtrument in Dialling, and is the *fourth Part* of a Circle, of any Opening of your Compaſſes, whatever you pleaſe:

The

to Fold out facing page 8

Fig I


90
80
70
60
50
40
30
20
10
A
C
B
90 80 70 60 50 40 30 20 10

A Line of Chords

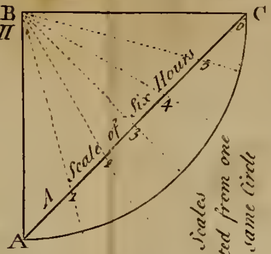

B
C
Fig II
A Scale of Six Hours
1
2
3
4
5
6
A

Fig 3

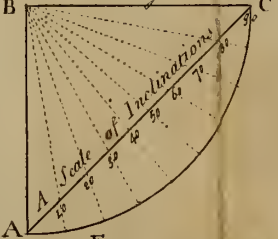
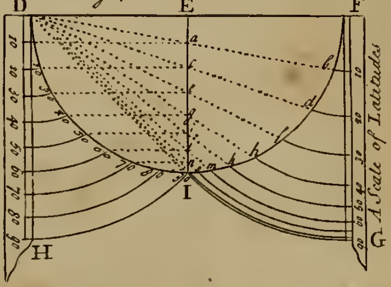
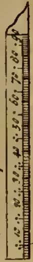

B
C
A Scale of Inclinations
10
20
30
40
50
60
70
80
90
A

Plate 2

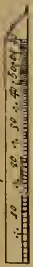
The Differant Scales uſed in Dialling

Fig 4

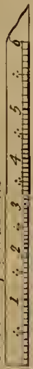

D
E
F
a
b
c
d
f
h
k
m
I
H
G
10 20 30 40 50 60 70 80 90
A Scale of Latitudes


10 20 30 40 50 60 70 80 90

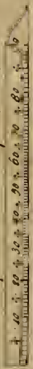
A Line of Chords


10 20 30 40 50 60

A Scale of Latitudes



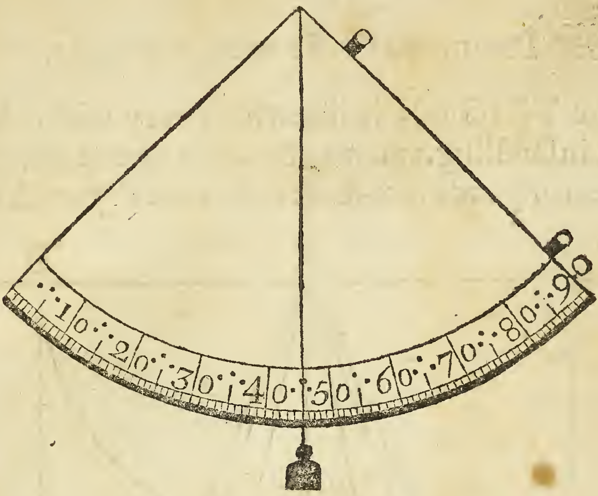
A Scale of Six Hours


10 20 30 40 50 60 70 80 90

A Scale of Inclination of Meridians

NB Theſe four Scales
are all Projected from one
Radius of the ſame Circle

The *Limb* or *Arch* thereof is divided into 90 *equal Parts,* called *Degrees,* and numbered with 10, 20, 30, &c. to 90. It has on one *Edge* two Sights, as



the annexed Figure. There are two Sorts commonly ſold in *London,* known by the Name of *Gunter*'s and *Collins*'s Quadrants, which have Lines of *Hours* and *Azimuth* drawn on the *Face,* to ſhew the *Hour* of the Day or Night, and the *Azimuth* of the Sun, at any Time, for the Latitude of *London* only.

N.B. If you buy either of theſe Quadrants, and take them far *North* or *South* from *London,* they will *there* be of no Service to you in finding the *Hour* and *Azimuth,* || but only in taking an *Altitude,* and other Purpoſes in Dialling, as will be ſhewn in its proper Place.

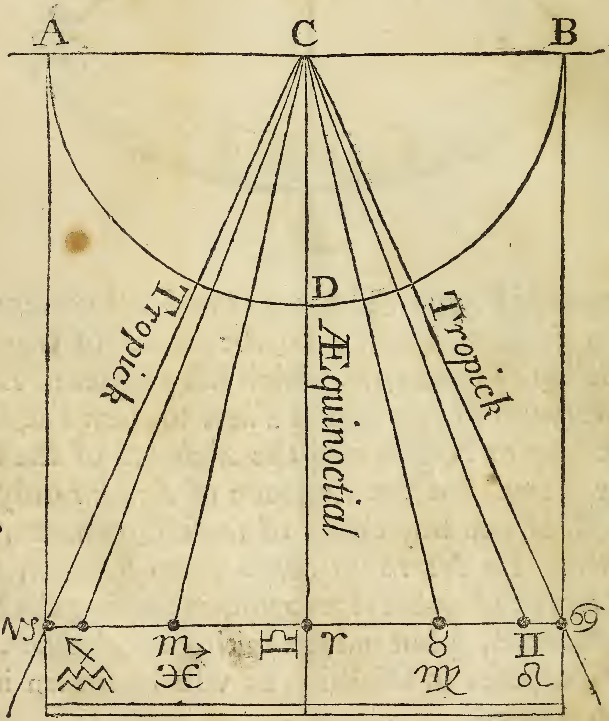
If you procure a good ſeaſoned Board that will not

|| Thoſe that would draw the *Hours* and *Azimuths* on a Quadrant, to any *particular* Latitude, may have Recourſe to my *Syſtem of Aſtronomy,* Vol. I. where they will find full Directions for thoſe Purpoſes.

warp, and thereon paſte a Sheet of good Paper, and draw ſuch a *Quadrant* as above repreſented, and fix thereto a *Thread* and *Plummet*, it will ſerve your Purpoſe well enough.

Prob. XIV. *To make a* Trigon.

The TRIGON is likewiſe a very uſeful Inſtrument in Dialling, and may be made upon a thin Board, or Sheet of good Paſte-board, as is the Figure AB ♋ ♑, of any convenient Size you pleaſe. At right Angles to AB, draw CD ♈, which ſhall repreſent the *Equinoctial*; with the *Chord* of 60 Degrees, draw the *Semicircle* ADB; take in your Compaſſes from the Line of *Chords* (Plate 2. Fig. 1.) 11 *Deg.* 30 *Min.*



(for ſuch is the Sun's Declination when he enters ♉ ♍ North, and ♏ ♓ South) and ſet one Foot in the Point D, that is, where the *Equinoctial* C D ♈ cuts the *Semicircle*, and turn the other Point *each Way* upon the Arch, there make Marks, and draw C ♉ ♍, and C ♏ ♓: Theſe two lines ſhall repreſent the *Sun's Declination* in the *Trigon*, when he enters *thoſe Signs*. Take 20 *Deg.* 11 *Min.* from your *Line of Chords*, (Plate 2. Fig. 1.) and ſet it from D, *each Way* upon the *Arch*, and thro' *thoſe* Points draw C ♊ ♌, and C ♐ ♒, theſe *two* Lines in the *Trigon* ſhall repreſent the Sun's Declination *North* and *South*, when he enters *thoſe* Signs. *

Laſtly, take 23 *Deg.* 29 *Min.* from your *Chords*, and ſet it from D *each Way* upon the Arch, and draw the *two* Tropicks of *Cancer* and *Capricorn*. At the *End* of *thoſe* Lines, *cloſe by* the Signs (where you ſee the Dots) you muſt make ſmall Holes, through which to put a Thread; and thus is your *Trigon* finiſhed, and fitted for the inſerting of the *Parellels* of the *twelve Signs*, into all Sorts of Sun-Dials, either *direct* or *reclining*.† But if you would put in *other Parellels* of Declination, ſuch as when the Days are juſt 8, 9, 10, 11, 12, 13, 14, 15, or 16 Hours long, then you muſt inſert into your *Trigon* ſuch Degrees of Declination as the Sun hath, when the Days are ſo many Hours long, as you would deſcribe upon your Dial; and ſo in the Latitude of *London*,

---

* The Sun's *Declination* is his *Diſtance* either *North* or *South* from the *Equinoctial*. *N. B.* It is *North* from the 21ſt of *March* to the 22d of *September*, and the reſt of the Year it is *South*. See Table I.

† The *Parallels* of the 12 *Signs* are the Sun's Declination that Day that he enters any *Sign*; as for Example, *Taurus* 11 Deg. 30 Min. as you find it in Table I.

When

When the Day is either	or	Hours long, the ſun hath	*Deg.*	*Min.*	Of Declination.
8	16		21	40	
9	15		16	55	
10	14		11	37	
11	13		5	55	

N. B. By the 25th Prob. of my *Syſtem of Aſtronomy*, Page 146, you may find theſe Declinations for any other Latitude.

CHAP. II. *Of* DIALLING *in General.*

DIALLING is a very *curious* and *uſeful* Art, and teacheth us how to draw *Hour-Lines* upon all Sorts of *Surfaces* or *Planes*, for any Place in the World, and thereby to know the apparent Hour of the Day, by the Shadow of a *Stile** fixed on the Plane *parellel to the Earth's Axis,* which *Stile* can have no more than *three* Poſitions, *viz. Perpendicular, Oblique,* or *Parellel,* which ſhall be ſhewn in their proper Places.†

A *Dial-Plane* is that Flat on which a Dial is intended to be projected.

The *Dial-Planes,* on which Hour-Lines are drawn, are theſe following:

---

* The *Stile* in Dialling ſignifies the Pin or Cock of a Dial, the Shadow of which points out the Hour.

† The whole Buſineſs of Dialling may be reduced to *three* general Heads; the *firſt* conſiſts in finding the Place of the *Subſtile,* or where the *Stile* is to be placed; the *ſecond* in drawing the *Hour-Lines*; and the *third,* and laſt, if the Dial-Plane be *moveable,* in duly placing and fixing the ſame, after the Dial is drawn thereon; or elſe, if the Plane, whereon the Dial is to be drawn, be *unmoveable,* and already fixed, in finding the *Poſition* or Situation of the ſaid Plane, *viz.* whether it be a *direct* or *declining* Plane, and if the *latter,* how far it *declines.*

The

The Horizontal The North and South erect direct The erect Decliner The Reclining Inclining The Reclining Declining The Convex The Concave	Dial-Plane.

The *Equinoctial* Dial-Plane is that which is *parellel* to the Plane of the *Earth's Equator,* and is *univerſal;* for Hour Lines drawn thereon, will ſhew the apparent Time of the Day in any Place of the World; and becauſe this is the *Ground* and *Foundation* of all other Dials, therefore I ſhall begin *firſt* with it, and, in the Courſe of this Work, ſhall ſhew how naturally the *Hour Lines,* upon all Sorts of Dial-Planes, are deduced from the *Equinoctial* Dial; but ſhall *firſt* furniſh you with the following Table.

A new correct *alphabetical Table of the principal* CITIES *and* TOWNS *in* England, Scotland, Ireland, *and* Wales, **ſhewing at each Place the* Elevation of the Pole, *and* Difference of their Meridians *from* London.

☞ The *Elevation of the Pole* ſignifies the ſame as the *Latitude of the Place;* and the *Difference of Meridians,* the ſame as the *Longitude of the Place.*

NOTE.

D H M	ſignifies	*Degrees* *Hours* *Minutes*

E W	ſignifies	Eaſt Weſt	*Longitude.*
N S		North South	*Latitude.*

* *N. B.* There is a Table of the moſt eminent *Cities* and *Towns* in the WORLD, in *Chapter* XXIV. near the latter End of this Work.

	Latit.		Diff.Merid.	
England.	D.	M.	H.	M.
BATH	51	25N	0	8W
Bedford	52	6N	0	2W
Berwick	55	45N	0	7W
Briſtol	51	26N	0	11W
Buckingham	51	57N	0	4W
Cambridge	52	12N	0	0W
Canterbury	51	16N	0	5 E
Carlile	54	48N	0	10W
Cheſter	53	10N	0	12W
Chicheſter	50	52N	0	3W
Colcheſter	51	57N	0	4 E
Coventry	52	26N	0	6W
Cronton *in* Lancaſhire	53	22N	0	12W
Derby	52	58N	0	6W
Dorcheſter	50	43N	0	11W
Dover	51	5N	0	5 E
Durham	54	47N	0	5W
Exeter	50	49N	0	14W
Flamborough	54	9N	0	1 E
Falmouth *in* Cornwall	50	9N	0	22W
Glouceſter	51	51N	0	9W
Guildford	51	15N	0	3W
Harborough *in* Leiceſterſhire	52	27N	0	5W
Hereford	52	4N	0	11W
Hertford	51	48N	0	0W
Hull	53	46N	0	1W
Huntingdon	52	18N	0	1W
Ipſwich	52	8N	0	5 E
Kendall	54	13N	0	11W
Lancaſter	54	0N	0	11W
Leiceſter	52	37N	0	5W
Lincoln	53	13N	0	2W
London*	51	32N	0	0W
Liverpool	53	25N	0	12W
Litchfield	52	42N	0	7W
Mancheſter	53	28N	0	9W
Newcaſtle *upon* Tyne	55	1N	0	5W
Northampton	52	12N	0	4W
Norwich	52	42N	0	6 E

	Latit.		Diff.Merid.	
	D.	M.	H.	M.
Nottingham	52	17N	0	4W
Ormſkirk	53	30N	0	12W
Orfordneſs	52	14N	0	6 E
Oxford	51	45N	0	5W
Penzance, Cornwall	50	8N	0	24W
Peterborough	52	33N	0	1W
Portſmouth	50	48N	0	5W
Preſton, Lancaſhire	53	42N	0	11W
Richmond, *in* Yorkſhire	54	20N	0	6W
Rocheſter, Kent	51	23N	0	3 E
Saliſbury	51	7N	0	8W
Shrewsbury	52	42N	0	11W
Southampton	50	53N	0	6W
Stafford	52	45N	0	9W
Stamford, Lincolnſhire	52	37N	0	1W
Truro	50	10N	0	22W
Wigan	53	34N	0	11W
Weymouth	50	37N	0	10W
Warrington	53	24N	0	10W
Warwick	52	18N	0	6W
Wells, Somerſet	51	15N	0	11W
Winchelſea	50	57N	0	3 E
Wincheſter, *in* Hants	51	7N	0	5W
Wolverhampton	52	38N	0	9W
Woodſtock	51	50N	0	6W
Worceſter	52	13N	0	9W
Yarmouth, Norfolk	52	44N	0	7 E
York	53	55N	0	4W
Wales.				
BAngor, Biſhop's See	53	21N	0	17W
Beaumaris	53	18N	0	17W
Brecknock	51	54N	0	14W
Caermarthen	51	53N	0	18W
Caernarvan	53	10N	0	18W

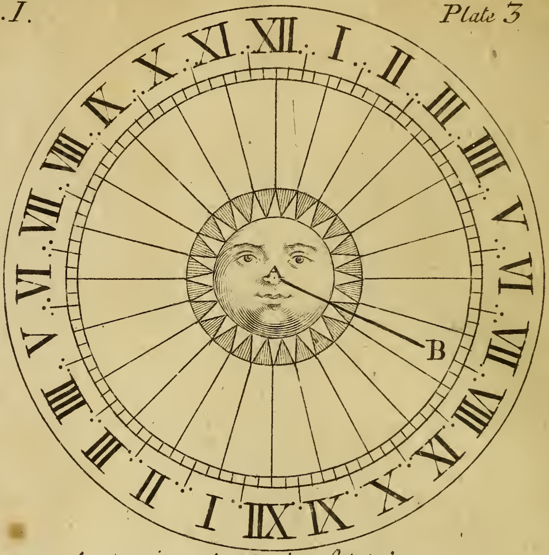
---

* Mr. *Norwood,* in his *Seaman's Practice,* Page 20, makes the Latitude of *London* 51 D. 30 M. and of *York* 53 D. 38 M. conſequently the Difference of Latitude between them is 2 D. 8 M.

Cardiff

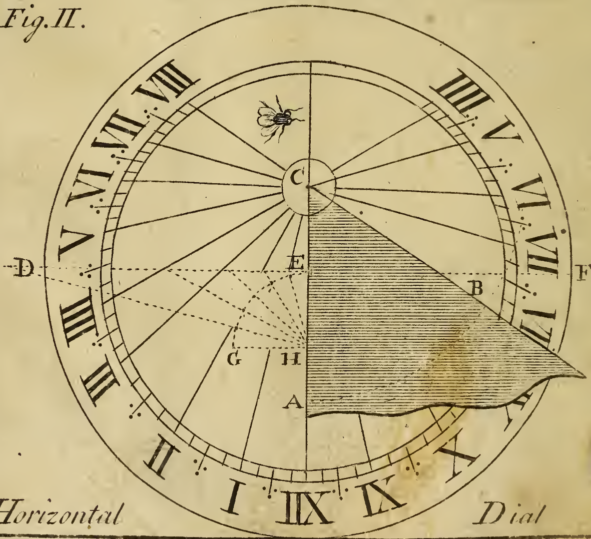
to Fold out Facing page 15

Fig. I. Plate 3


XII
I
II
III
IIII
V
VI
VII
VIII
IX
X
XI
XII
I
II
III
IIII
V
VI
VII
VIII
IX
X
XI
B

An Equinoctial Universal Dial

Fig. II.


IIII
V
VI
VII
VIII
IX
X
XI
XII
I
II
III
IIII
V
VI
VII
VIII
C
D
E
F
B
G
H
A

Horizontal Dial

	Latit.		*Diff.Merid.*	
	D.	M.	H.	M.
Cardiff	51	42N	0	13W
Cardigan	52	8N	0	19W
Denbigh	53	10N	0	14W
Flint	53	12N	0	13W
Harlech, *in* Merionethſhire	52	53N	0	17W
Landaff	51	43N	0	13W
Milford	51	43N	0	20W
Monmouth	51	50N	0	11W
Montgomery	52	34N	0	13W
Pembroke	51	42N	0	20W
Radnor	52	21N	0	12W
St. Aſaph	53	15N	0	13W
St. Davids	55	1N	0	21W
Welſhpool	52	40N	0	13W
Wrexham	53	2N	0	13W
Britiſh Iſlands.				
Angleſey-Middle	53	20N	0	18W
Guernſey	49	36N	0	11W
Jerſey	49	28N	0	14W
Lundy	51	20N	0	15W
Man	54	25N	0	18W
Portland	50	30N	0	11W
Wight	50	37N	0	6W
Yarmouth *in ditto*	50	44N	0	7W
Scotland.				
Aberdeen	57	6N	0	7W
Dunbar	55	57N	0	9W
Dundee	56	30N	0	13W
Dumblain	56	14N	0	16W
Dunkeld	56	37N	0	13W
Edinburgh	55	57N	0	12W
Glaſgow	56	20N	0	17W
Leith	54	58N	0	12W
Orkney	60	6N	0	14W
St. Andrews	56	19N	0	10W
Stirling	56	10N	0	15W
Ireland.				
Antrim	54	47N	0	26W
Ardglas	54	19N	0	24W
Armagh	54	22N	0	28W
Belfaſt	54	36N	0	27W
Caterlagh	52	48N	0	29W
Clare	52	41N	0	37W
Cork	51	45N	0	36W
Colerain	55	8N	0	28W
Drogheda	53	43N	0	26W
Dublin	53	16N	0	26W
Dundalk	54	3N	0	27W
Galloway	53	12N	0	32W
Kent	52	39N	0	30W
Kildare	53	8N	0	29W
Kinſale	51	31N	0	38W
Londonderry	54	55N	0	32W
Limerick	52	36N	0	31W
Maryborough	53	0N	0	31W
Philipſtown	53	15N	0	32W
Tuam	53	26N	0	37W
Waterford	52	13N	0	29W
Wexford	52	19N	0	27W
Youghall	51	51N	0	33W

CHAP. III. *To make an* Equinoctial* *Dial.*

Plate 3. Fig. 1.

THIS Dial, of all others, is the moſt ſimple and eaſy to be drawn, and is thus made:

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* *Equinoctial Dials* are thoſe whoſe *Plane* or *Face* lieth *parallel* to the Equinoctial.

Take a *flat* Plate of Braſs, about a Foot ſquare; or if you cannot eaſily procure Braſs, get a Piece of good dried Oak, well planed on both Sides.

For the Hour Lines.

Draw with your Compaſſes *three* † *concentric Circles* thereon, to contain the Figures, which divide into 24 *equal Parts*; then lay a Ruler to the *Center*, and draw Lines to thoſe *equal Diviſions* in the *Circle*, and they ſhall be the true *Hour Lines* ſought.

For the Stile.

Erect in the *Center* of the Plate a Pin or Wire *perpendicular* to the Plane, as A B, and that ſhall be the *Stile* truly fitted to the Dial.

You muſt obſerve, that 15 *Deg.* ‖ in the *Equinoctial* is *one Hour in Time*, as you may ſee more at large by Table III. and therefore, if you take 15 *Deg.* from your *Line of Chords*, and ſet it off from the 12 *a-Clock Line each Way*, that will give you the Hours of 11 and 1, and 30 *Deg.* will give you the Hours of 10 and 2, *&c.* and thus the whole *equinoctial Circle* will be divided into 24 *equal Parts* or *Hours*, as above.

But becauſe this Dial, when thus drawn on *one* Surface or *Side* of the Plane, will ſerve only for one Half of the Year, *viz.* while the Sun is on *one Side* of the *Equinoctial*, to wit, from the 22d of *March* to the 21ſt of *September*; and therefore to make it ſerve for the *whole Year*, it muſt be *doubly* drawn, *i. e.* on the *lower*, as well as on the *upper Side* or Surface of the Plane, and then the Wire, which ſerves for the *Stile*, muſt go through the *Center*, and muſt extend itſelf 6 or 8 Inches more or leſs *beyond* the Surface of the Plane, and ſtand at *right Angles* therewith; *and then that Dial is finiſhed.* How naturally the *Hour Lines* of all Dials are drawn from the *Equinoctial Dial* is ſhewn in Chapter XXI.

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† See Problem VI. Page 5.

‖ Throughout this Book you will find continual Mention made of *Degrees* and *Minutes*, therefore you are to remember, that a *Degree* is the 360th Part of any Circle; *each* of which Degrees is ſuppoſed to be divided into 60 Minutes; ſo that 45 Minutes is *three Quarters* of a Degree, 30 Minutes *Half* a Degree, and 15 Minutes a *Quarter* of a Degree, *&c.* See Table III.

To ſet this Dial truly.

You muſt raiſe the Wire, which repreſents the *Stile*, to the *Latitude* of your Place, by applying that Edge of your *Quadrant*, in which the Sights are fixed, to the *Stile*, and when the *Thread* cuts the *Limb* in the *Degrees* of the *Latitude* of *your Place*, then doth the *Stile* point to the *Poles of the World*, and the Dial itſelf *lieth parallel* to the *Equinoctial Circle* in the Heavens. But ſtill here wants *a true* 12 *a-clock Hour Line*, which muſt be found as I ſhall ſhew in the next Chapter, and then placing the Dial, ſo that at 12 *a-clock* the *Shadow* of the *Stile* may fall in the 12 *a-clock Hour Line*, that you find by the Directions following: and thus will your Dial be *truly placed*, which you may faſten by fixing two Pieces of Iron at each End of your 12 *a-clock Hour Line* upon your *Dial Poſt*, and in thoſe put the *Stile* of the Dial to the *Height*, which was found before by the Help of your *Quadrant*.

CHAP. IV. *To make an* Horizontal * *Dial.*

Plate 3. Fig. 2.

THIS is the moſt *uſeful* Dial of all others, becauſe the Sun ſtayeth upon it from his *Riſing* to his *Setting*, *in all Places*, of the World, whereſoever you be.

It matters not what Form the Plane, on which you would draw an *Horizontal Dial*, is, whither it be *round*, *ſquare*, or *triangular*, but they are generally drawn round, as on Plate 3. Fig. 2. in which, when you have drawn *three concentric Circles*, as a Margin to contain the Figures, draw the Line CA, which ſhall repreſent the 12 *a-clock Line*, and alſo the *ſubſtilar Line*, in which make choice of a Point, as at C, a little above the *Center* (for by that Means you will inlarge the Diſtances of the *Hour Lines*) and through it draw the Line VI. C. VI. for the 6 *a-clock* Hour Line. In the *ſubſtilar* Line,† as at E, make choice of *another Point* and through that, at *right Angles to the* 12 *a-clock Line*, draw the *Line* DEF; having proceeded thus far, let it be required to make an *Horizontal* Dial to the Latitude of *Durham*, which is 54 Deg. 47 Min. *North*; open your Compaſſes to the *Chord* of 60 Deg. ſet one Foot in C, draw the Arch AB, and take the *Chord* of 54 Deg. 47 Min. and ſet it from A to B, and draw the Line CB for the *Stile*, ſo is ACB the true Form and Shape of your *Dial Cock* or *Stile*; ſet one Foot of your Compaſſes in E, that is, where the Line DEF cuts the 12 *a-clock Line*, and take the neareſt Diſtance to the Line CB, or *Stile*'s *Height*, turn *that* Point of your Compaſſes about, and make another Mark in the 12 *a-clock Line* at H; this Point H repreſents the *Center* of the Equinoctial. On H, *as a Center*, draw the *Quadrant* GE, and divide it into *ſix equal Parts*; lay a Ruler to H, and to thoſe *equal Parts* in the Arch *ſeverally*, and where the Ruler *cuts* the *Line* DEF, the Points are through which the *Hour Lines* muſt paſs; then lay a Ruler to the *Center* at C, and to thoſe Marks in the Line DEF, and draw the *Hour Lines*; ſet off the *ſame* Diſtances in the *Line* DEF, from E towards B, and draw the *Morning Hours*; thoſe *before ſix* in the Morning and *after ſix* at Night, are drawn by continuing the *ſame Hour Line beyond the Center* C.

---

* *Horizontal Dials* are thoſe whoſe *Plane* or *Face* lies *parallel* to *Horizon* of the Place.

† The *ſubſtilar Line* in Dialling is that Line drawn upon the Plane or Face of the Dial, *over which the Stile ſtands perpendicular*, or at *right Angles*. *Note*, This is not the 12 *a-clock Line* in all Dials, tho' it is in the *Horizontal*, and *South* and *North Erect Direct* Dials.

To ſet it truly.

The Dial being thus finiſhed, the next Thing is *to ſet it truly*; for if it be ever ſo truly made, and not well ſet, it will go wrong: therefore you muſt firſt ſee that your Poſt, on which the Dial is to ſtand, be truly level every Way, which you may try by your *Quadrant*, on which draw *a Circle* as large as the Top of the Poſt will bear; in the *Center* thereof place a Pin *exactly upright*; in the *Forenoon*, when the Sun ſhineth, let the *End of the Shadow* of the Pin touch the *Circle*, where *make a Mark*; let Things ſtand thus till *Afternoon* the ſame *Day*, and then obſerve where the *Top* of the Shadow of the Pin toucheth the ſame Circle; there again *make a ſecond Mark*; then divide the Diſtance of theſe *two* Marks into *two equal Parts*, and from *that* through the *Center* draw a Line, which ſhall be the 12 *a-clock Hour Line*, and ſet the 12 *a-clock Line* of your Dial upon this 12 *a-clock Line on the Poſt*; ſo ſhall your Dial be truly placed, which may be faſtened at your own Diſcretion.

Note, Inſtead of the *Quadrant* GE, you may draw a *Semicircle* on the *Center* H, and divide it into 12 *equal Parts*, and ſo Lines drawn from the *Center* at H will give the Points in the *Line* DEF, as before. Or, if you apply the *Center* of the *Equinoctial Dial* to the *Center* at H, the *Hour Lines* on the *Equinoctial Dial* will cut the *Line* DEF in the Points where the *Hour Lines* on the *Horizontal Dial* muſt paſs.

☞ For drawing the *Half Hours* and *Quarters*, upon all Sorts of Dials, *you are to obſerve*, that as you divided the Circle, which repreſented the *Equinoctial* (into 24 *equal Parts)* for the *Hours*, ſo you are to divide *each* of thoſe Parts into 4 *equal Parts more*, and thoſe will be the *Quarters*.

N. B. That in *placing* of Dials, when made, excepting the *Equinoctial* and *Horizontal Dial*, you have no Occaſion to regard the Place where they are to be fixed, for the *Hour Lines* being drawn according to the *Declination* or *Reclination* of the Place, it gives you the *true Situation* of the Dial itſelf.

CHAP. V. *To make an erect* * *direct* South *Dial.*

Plate 4. Fig. 2.

THIS *Dial Plane* is no more than an *upright* Wall, which *exactly* faces the true *South* Point.

As

* 1. Thoſe *Planes* are ſaid to be *erect* or *upright*, which ſtand *perpendicular* to the *Horizon of the Place*; and ſuch are the Walls of Churches, Houſes or the like, againſt which, for the moſt Part, Dials are placed.

2. Of

As the *Elevation of the Pole* above the *Horizontal Plane* was *equal to the Latitude of the Place:* ſo in this it is the *Complement of the Latitude* of the Place, or what it wants to make it up 90 Degrees.

The Sun never ſtays 12 *Hours* upon *this Plane*, but when in the *Equinoctial*; becauſe the *Plane* itſelf lieth in the *prime Vertical*, or *Eaſt* and *Weſt Azimuth*; for, from *March* 20, to *September* 23, he doth not come *due Eaſt* till after 6 in the *Morning*, and is *due Weſt* before 6 at Night: ſo that when in the Tropic of ♋ he is *due Eaſt* at 7H. 20M. 48 S. and *due Weſt* at 4H. 39M. 12S. conſequently his Stay then upon the *Plane* is only 9 H. 18 M. 24 S. See my *Aſtronomy*, P. 104.

For the Hour-Lines.

When you have made choice of your Plane, draw the *Horizontal Line* VI, VI, for the *Eaſt* and *Weſt* Line, or *Hour Line* of *Six*; from A let fall the *Perpendicular* A F, for the 12 *a-clock Hour Line*; then with your Compaſſes take 60 *Deg.* from the *Line of Chords*, and draw the *Arch* BC VI; take the *Complement of the Latitude* of your Place, which, in this Example, I'll ſuppoſe to be *Cheſter*, whoſe *Latitude*, as you find it in the Table, is 53 Deg. 10 Min. *North*, and ſet 36 Deg. 50 Min. its *Complement*, or what it wants to make it up 90 Degrees from B to C; draw A C for the *Height of the Stile.*

---

2. Of theſe *erect* or *upright Planes* there are *two* Sorts, *viz. Direct* and *Declining*. 3. Thoſe *erect* or *upright Planes* are ſaid to be *direct*, which *directly* face the Eaſt, Weſt, North, or South *Points* of the *Horizon*, and theſe are called *erect direct Planes*. 4. Thoſe *erect* or *upright Planes* are ſaid to *decline*, which do not *directly* face the Eaſt, Weſt, North, or South Points, but look upon ſome *other Points* ſituate betwixt them, *viz. South-Eaſt, North-Weſt, North-Eaſt, &c.* and theſe *Planes* are called *upright* or *erect, declining Planes*. How *the Declination* is to be found, is taught in Chap. X.

Make choice of any Point, at Pleaſure, in the 12 *a-clock Line*, as I; through I, at *right Angles* to the 12 a-clock Line, draw the Line DIE; ſet one Foot of your Compaſſes in I, and take the *neareſt Diſtance* to the *Height of the Stile* AC, and turn that Point of your Compaſſes down to F, and there make a Mark in the 12 *a-clock Line*, on which Point F deſcribe the *Semicircle* GIH, and divide it into 12 *equal Parts*, for that *Semicircle* repreſents *one Half* of the *Equinoctial*; lay a Ruler to F, and to *thoſe Marks* in the *Semicircle* juſt now made, and draw Lines from thence to the *Line* DIE. Laſtly, draw Lines from A to *thoſe Marks* in the *Line* DIE, and they ſhall be the true *Hour Lines* upon your Dial's Plane.

For the Quarters.

The *Quarters* are drawn in like Manner, by dividing the *Semicircle* into 48 *equal Parts*, ſo that *one* Quarter will be 3 *Deg.* 45 *Min.* *two* Quarters 7 *Deg.* 30 *Min.* and *three* Quarters will be 11 *Deg.* 15 *Min.* as you may ſee by Table III.

Having thus finiſhed the *Hour Lines*, place 12 at the *End* of the Line AF, and if it is a *South Dial*, as ſpecified above, and your Face toward it, you muſt place the *Morning Hours* on the *left Hand*, and the *Afternoon Hours* on the *right*, as you ſee done in the Figure.

For the Stile.

If your Plane be large, it will be beſt to get an iron Rod, about the *Thickneſs* of your *Hour Lines*, for the *Stile*, and be ſure to place it exactly over the 12 *a-clock Hour Line*, and to make an Angle with your Plane equal to the *Complement of Latitude*, which is done by applying the Edge of your Quadrant to it, and ſo fix it, when you find it ſtands true.

For the Thickneſs *of the* Stile.

☞ *Be ſure* you always mind to make Allowance for the *Thickneſs of the Rod* which is to be the *Stile*, and this is to be done when you draw the *Semicircle* GIH, by having *two Centers* at F, diſtant *juſt the Thickneſs of the Stile*; otherwiſe, if this Care be not taken, your Dial will go too *ſlow* in the *Forenoon*, and too *faſt* in the *Afternoon*.

CHAP. VI. *To make an erect direct* North *Dial.*

Plate 4. Fig. 1.

THIS *Dial Plane* is no more than an *upright Wall* that exactly faces the *true North Point*. This Dial is of no Uſe from *September* the 22d to *March* the 21ſt, that is, while the Sun is in the *ſix Southern* Signs,* to us who inhabit the *Northern Hemiſphere*, becauſe it only ſhews the Time from *Sun riſing* to *ſix* in the *Morning*, and in the *Afternoon*, from *ſix* till *Sun ſetting*; for *this Dial*, and the *South Dial*, make up the *Horizontal Dial*, *i. e.* takes in all the Hours of the *longeſt Day*; and as the *Stile* of the *South Dial* points *downwards*,

---

The *Six Northern* Signs are,   * The *Six Southern* Signs are.

Aries	♈	*Cancer*	♋	*Libra*	♎	*Capricorn*	♑
Taurus	♉	*Leo*	♌	*Scorpio*	♏	*Aquarius*	♒
Gemini	♊	*Virgo*	♍	*Sagittary*	♐	*Piſces*	♓

wards, ſo of the *North* the *Stile* points *upwards*, and makes an *Angle* with the Plane equal to the *Complement of the Latitude* of the Place, *i. e.* what the Latitude of the Place wants to make up 90 Deg.

The making of this is the very ſame as the *South Dial*; for having made choice of your Plane, draw the *Horizontal Line* 6, A 6, for the *Eaſt* and *Weſt Line*; *about the Middle*, at A, erect the *Perpendicular* AB, which ſhall repreſent the 12 *a-clock Hour Line* (though the Figure 12 needs not be put to it.)

For the Stile's Height.

On the Point A, with the *Chord* of 60 *Deg.* draw the Arch CD; take from your Chords the *Complement of the Latitude* of your Place, as ſuppoſe *York* 36 Deg. 5 Min. and ſet it from C to D; then draw AD for the *Stile's Height*.

For the Hour Lines.

Make choice of *any Point* convenient for your Purpoſe, in the 12 *a-clock Line* AB, as the Point E, through which, at *right Angles to the* 12 *a-clock Line*, draw the Line FEG; ſet one Foot of your Compaſſes in E, and take the *neareſt Diſtance* to the *Stile's Height* AD; ſet *that Diſtance* from E to B, ſo ſhall the *Point* B be the *Center* of the *Equinoctial*; on B, with the *Diſtance* BE, draw the *Semicircle* HEI, and divide it into 12 *equal Parts*; lay a Ruler to the *Center* B, and to *thoſe* Marks in the *Semicircle*, and where the Ruler cuts the *Line* FEG, are the Places where the *Hour Lines* muſt paſs, which muſt be drawn from the *Center* A.

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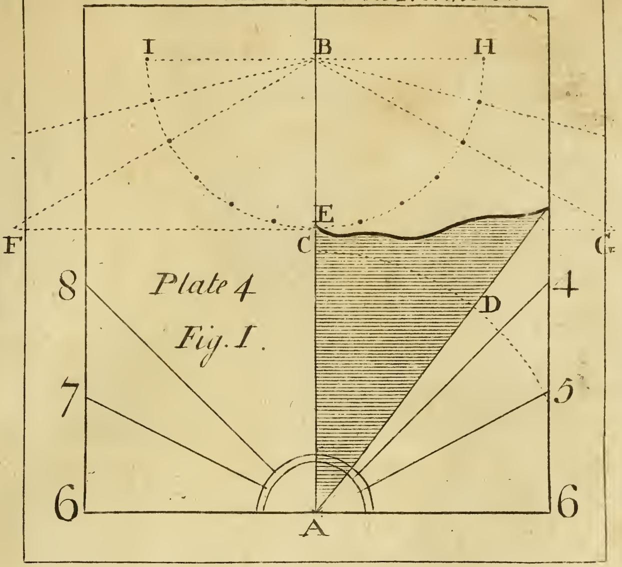
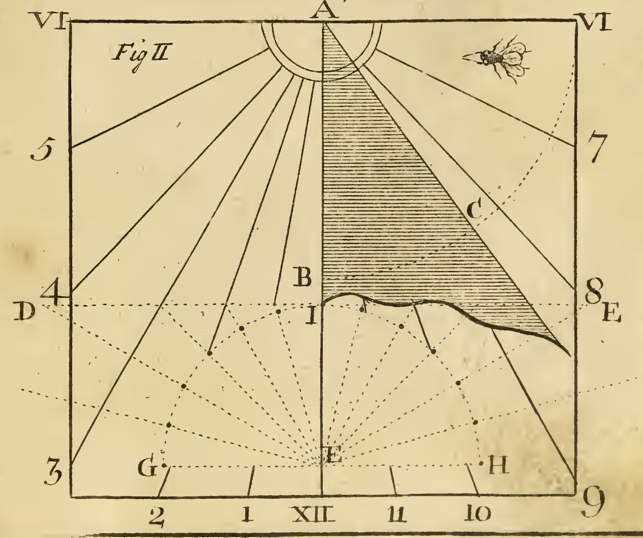
An Erect Direct North Dial


I
B
H
E
F
C
G
8
Plate 4
Fig. I.
4
D
7
5
6
6
A

An Erect Direct South Dial


VI
A
VI
Fig II
5
7
C
B
4
8
D
I
E
3
G
E
H
9
2
1
XII
11
10

On *this* Dial there is not any Occaſion of drawing any more *Hour Lines* than 4 and 5 in the *Morning*, and 7 and 8 at *Night*.

For the Stile.

Over the 12 a-clock Line AB, at *right Angles*, fix the *Stile*, ſo that it may make an Angle with the Plane, equal to the *Complement of the Latitude of the Place*, which you muſt try by Help of your *Quadrant*, as has been before directed in the *South Dial*; and thus is the *North Dial* compleatly finiſhed.

N. B. The *Quarters* and *Half Hours* are drawn as has been taught in *Pages* 20 and 22.

CHAP. VII. *To draw an erect direct* Eaſt *Dial.*

Plate 5. Fig. 1.

THIS Dial's Plane lieth in the Plane of the *Meridian of the Place*, *i. e.* is no more than an *upright Wall*, that exactly faces the *true Eaſt Point*. The *Hour Lines* are all *parallel to each other*, and to the *Axis of the World*, and conſequently have *no Centers*; the Sun comes on it at his *Riſing*, and continues thereon till *near Noon*.

The *ſix a-clock Hour Line* is the *Subſtilar Line*, over which the *Stile* is fixed at *right Angles*, and may be either a *thin Plate* of Iron, or a *perpendicular* Wire, &c. whoſe *Height* muſt be equal to the *nine a-clock* Hour Line in this Dial, and to the *three a-clock* Hour Line in the *Weſt* Dial.

Having then made choice of your Plane, *about one third* of the Diſtance from the *Bottom*, draw the *Horizontal Line* ACH; in ſome *convenient Place*, as at C, draw a *Circle* with the *Chord* of 60 *Degrees ſure*; then take the *Chord* of the *Latitude of the Place*, as ſuppoſe at *Oxford* 51 Deg. 45 Min. and ſet from H to P, and draw PCS, which ſhall be the *Subſtilar Line*, and *ſix a-clock* Hour Line, to which at *right Angles*, draw CD for the *Equinoctial*.

Next draw the Line ASB, *parallel* to the *Equinoctial*, and divide the *Quadrant* SD into *ſix equal Parts*; lay a Ruler to the *Center* at C, and to thoſe *equal Parts* in the Circle, and it will cut the *Line* AB in the Points where the *Hour Lines* muſt paſs, through *which Points*, in the Line ASB, draw the *Hour Lines parallel* to the *ſix a-clock Hour Line*, which are the true *Hour Lines* from *Six* till *Noon*; the Hours of 4 and 5 in the *Morning* are the *ſame Diſtance from* 6 on one Side, as 7 and 8 are on the *other*.

The *Quarters* are drawn by ſubdividing the *Diviſions* in the *Circle* into *four* equal Parts, as *has* been above directed.

Of fixing the Stile.

The Hour Lines being thus drawn, fix the *Stile* at right Angles on the *Subſtilar Line*, as before directed, and your Dial is compleatly finiſhed.

This Dial is univerſal, by placing the Earth's Axis parallel to the Axis of the World, in what Latitude ſoever you be.

N. B. The Earth's *Axis*, in this Dial, is repreſented by the *ſix* a-clock Hour Line. See the Deſcription of the *Sphere*. *See* alſo the End of *Chap*. XXI.

CHAP. VIII. *To draw an erect direct* Weſt *Dial.*

Plate 5. Fig. 2.

THIS *Dial Plane* is no more than an *upright Wall* that exactly *faces* the *true Weſt Point.*

The making of this is the very ſame, in all Reſpects, as making of the *Eaſt Dial,* only as the *Eaſt* Hour Lines are elevated to the *right Hand,* ſo here they are elevated to the *left Hand.*

The Hour of 12 can never come upon either the *Eaſt* or *Weſt* Dial Planes, becauſe at that Hour the Sun being upon the *Meridian,* the Shadow of the Stile will be *parallel* to the Plane, and conſequently can caſt no Shadow upon it.

For the Hour Lines *and* Subſtilar Line.

Then, having your Plane in Readineſs, at about *one Third* of the Depth of the Plane *from the Top,* draw the *Horizontal Line* AH, and make choice of a *convenient Point* therein, as at C, and draw the *Circle* PHDS; take 50 Deg. 49 Min. from your *Line of Chords* (that being the Latitude of the City of *Exeter)* and ſet that Diſtance juſt now taken from your *Line of Chords,* from H to P; draw PCS for the *Subſtilar Line,* and *Hour of Six.* [2] And, at *right Angles* thereto, draw CD to repreſent the *Equinoctial,* and draw the *Line* BA to touch the *Circle* in S, *parallel* to CD. [3] *Divide* the *Quadrant* DS into *ſix equal Parts,* and lay a Ruler to the *Center* at C, and to *each Mark* in the *Quadrant* DS, and it will cut the *Line* BA in *the Points* where the *Hour Lines* are to paſt. [4] Through *thoſe* Marks, in the Line BA, draw Lines *parallel* to the *ſix a-clock Hour Line,* and they ſhall be the true *Hour Lines* upon the *Dial.* The Hours of 7 and 8 in the *Evening* are the *ſame Diſtance* from 6, that 5 and 4 are on the *other* Side.

For the Quarters *and* Half Hours.

The *Quarters* and *Half Hours* are drawn in both theſe *Eaſt* and *Weſt* Dials, by *dividing* each *ſixth Part* of the *Quadrant* DS into *four equal Parts,* and carrying them into the *Line* AB, by laying the Ruler to the *Center* C, and to *thoſe* Parts in the *Arch* DS, as you were taught in drawing the *Hour Lines.*

For fixing the Stile.

Fix the *Stile* upon the *ſix a-clock Hour Line,* and at *right Angles* thereto, which may be a Plate of *Copper, Braſs* or *Iron,* as in Plates 5 and 6, whoſe *Height* muſt be *equal to* CD, or the *three a-clock* Hour Line, and then is your Dial finiſhed.

See alſo the *End* of *Chapter* XXI.

CHAP. IX. *To make* a Polar *Dial.*

Plate 6.

THIS Dial is called by ſome Authors an *Equinoctial Dial,* and by others a *Polar Dial;* but, be that as it will, it is plain, that all Places, lying under the *Equinoctial* have *no Latitude;* as for Inſtance, the *Iſland of St. Thomas* has *no Latitude,*

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An Erect Direct Eaſt Dial

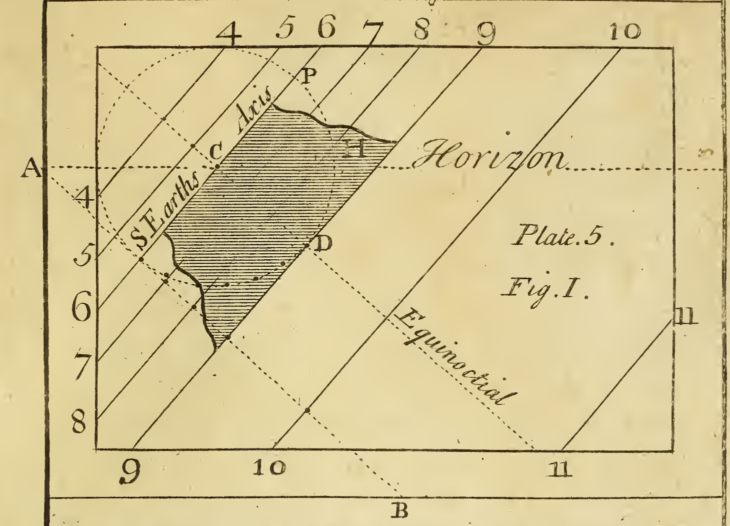
4 5 6 7 8 9 10
P
Axis
C
H
Horizon
A
4
S Earths
5
D
6
7
8
Equinoctial
11
9
10
11
B

Plate. 5.

Fig. I.

An Erect Direct Weſt Dial

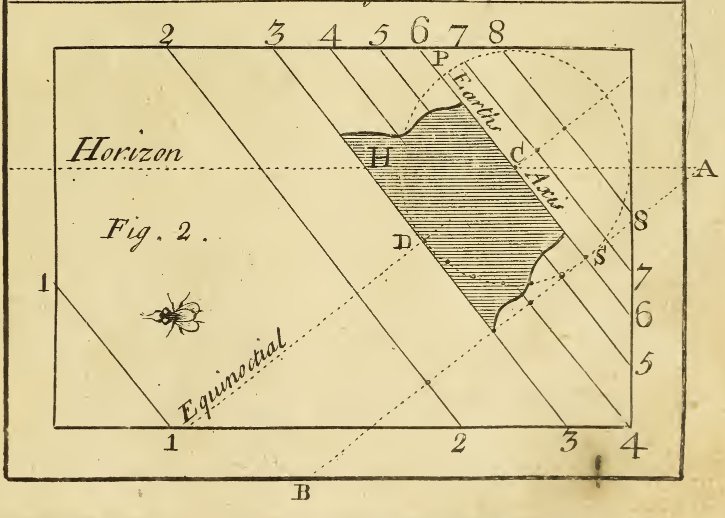
2 3 4 5 6 7 8
P
Earths
Horizon
H
C
Axis
A
D
S
8
7
6
5
1
Equinoctial
1
2
3
4
B

Fig. 2.

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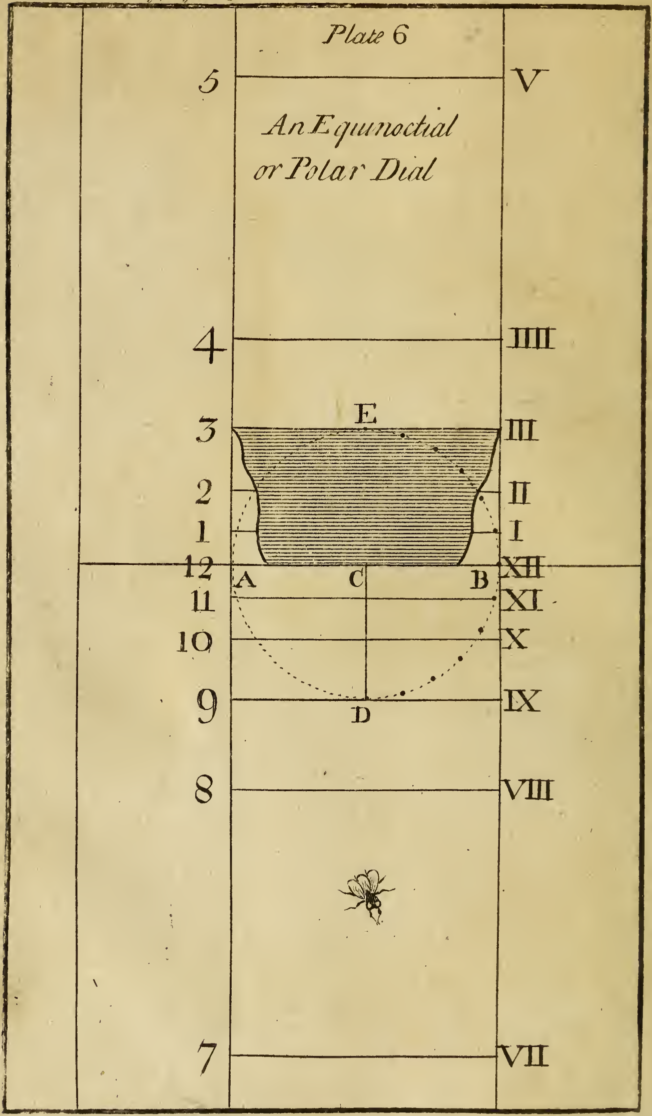

Plate 6

An Equinoctial or Polar Dial

5
V
4
IIII
E
3
III
2
II
1
I
12
XII
A
C
B
11
XI
10
X
9
IX
D
8
VIII
7
VII

tude, for which this *Dial* is made, and for that Reaſon the *Hour Lines* cannot have any *Center*; and therefore all the *Hour Lines* drawn upon theſe *Dials* will be *parallel* to each other.

For the Hour *and* Subſtilar Lines.

☞ [1] To draw the *Hour Lines* upon this Plane, *firſt* draw AB for the *Subſtilar Line* and *Hour Line* of XII. [2] On C, as a *Center*, with the *Chord* of 60 *Deg.* draw the *Circle* AEBD, and draw the *two* Lines, V. VII. and 5. 7. *divide* the *Semicircle* EBD into 12 *equal Parts*; lay a Ruler to the *Center* of the *Circle* at C, and to *each* Mark in the *Circle*, and it will cut the Line V. VII. in the Points where the *Hour Lines* muſt paſs. [3] *Through* which Points draw Hour Lines *parallel* to AB, and they ſhall be the *true Hour Lines* that were required.

For the Stile.

The *Stile* may be a broad Plate of *Copper*, *Braſs* or *Iron*, at Pleaſure, placed at *right Angles* over the 12 *a-clock Hour Line.*

The *Hour Line* of *ſix* never falls upon this Dial, becauſe *under the Equinoctial* the Sun *riſes* and *ſets* at *Six the Year throughout*, with very little Variation.

CHAP. X. *To find the* Declination * *of a* Wall *or* Plane *whereon to draw a* Sun-Dial.

Plate 7. Fig. 9.

A Deſcription of the Inſtrument.

[1] PROCURE an oaken Board (which at *London* they call Wainſcot) about a Foot ſquare, more or leſs, it matters not; take ABCD, about an Inch thick, well planed on both Sides, and thereon paſte a Sheet of good Paper very ſmooth, on which draw *two* or *three concentric* Circles, it matters not how many, nor at what Diſtance they be. [2] In the *Center* I, let there be an Hole to receive a *ſtreight Wire* to ſcrew up and down at Pleaſure, and to ſtand at *right Angles* to the Board itſelf; draw *two* Diameters, and mark them with the Letters of the four *cardinal Points, Eaſt, Weſt, North* and *South,* which *Line* NS repreſents the *Axis* of the *Wall, i. e.* it ſtands *perpendicular,* or at *right Angles,* to the *Wall itſelf;* and if it doth not decline from the *South* or *North,* nor yet to the *Eaſt* or *Weſt,* the ſaid Line alſo repreſents the 12 *a-clock Hour Line.*

To take the Declination.

[3] When you would take the *Declination* of a *Wall,* apply the *Edge* of the Inſtrument AB to the Wall; and in the *Forenoon,* the *Sun ſhining,* by the Help of your *Quadrant* place the Inſtrument parallel to the Horizon; ſcrew up your *perpendicular*

---

* See Page 21, Note 4.

Pin in the *Center* 'till the *Shadow* of its *Top* touch *any of the Circles*, it matters not which, as ſuppoſe the *outmoſt* at F; let all Things now reſt 'till *Afternoon.* [4] *And* then carefully obſerve where the *Top* of the *Shadow* toucheth the *ſame Circle* again, which we will ſuppoſe at G; thus is your Obſervation finiſhed. [5] Take your Inſtrument down, and with your Compaſſes *divide* the *Arch* FG into *two* equal Parts in H, and if from H you draw a Line through the *Center*, it ſhall be a *true* 12 *a-clock Hour Line*; and NH is the *Declination of the Wall*, which, by applying it to the *Line of Chords*, I find to be 14 Degrees. And when the Mark, laſt found at H, falls on the *Eaſt Side* of the Line NS (as this doth) then is the *Declination* of the Wall *Eaſt*; but when the Mark falls on the *Weſt Side*, then the *Declination* is *Weſt*.

Note, The Curve, that the Top of the Pin deſcribes, is always an Hyperbola, whether it be perpendicular, or incline to the Horizon; and ſuch are alſo the Parallels of the Sun's Declination when put upon a Dial.

CHAP. XI. *To make an erect* Declining *Dial.*

THE *upright* or *erect* Dial Planes, already treated of, are ſuch as did *directly* face the *four cardinal* or principal Points of the *Horizon*, viz. *Eaſt*, *Weſt*, *North* and *South* Points. Now ALL OTHER *upright* or *erect* Dial Planes are ſaid to *decline*, * and their *Declination* is counted from the *North* or *South*, towards *Eaſt* and *Weſt*, and thoſe Planes are called *South* or *North* erect Planes *declining Eaſt* or *Weſt*.

---

* See Page 21, Note 4.

Plate 7. Fig. 2.

Let it be required to make a Dial in the *Latitude* of 53 *Deg.* 25 *Min. North, declining* from the *South* to the *Weſt* 21 *Deg.* 10 *Min. viz.* for *Liverpool, Warrington,* or *Cronton,* in *Lancaſhire.*

Firſt, *For the* Diſtance *of the* Subſtilar Line *from the* 12 a-clock Hour Line.

[1] Draw the *Horizontal Line* AB, and from C let fall *perpendicular* the 12 *a-clock Hour Line* CD, and from the *Line of Chords* take 60 *Deg.* with your Compaſſes, and ſet one Foot of your Compaſſes in C, and draw the *Semicircle* ADB. [2] And then draw CD at *right Angles* to AB, for the 12 *a-clock Line.* [3] Take the *Complement of the Latitude* 36 Deg. 35 Min. from your *Line of Chords,* and ſet it from D to E, and draw EF *parallel* to AB, ſo is FE the *Sine* † of the *Arch* DE. This done, [4] take in your Compaſſes the *Plane's Declination* 21 Deg. 10 Min. from your *Line of Chords,* and ſet it from D to G, and draw CG. [5] Take EF in your Compaſſes, and ſet it from CtoH; draw HI *parallel* to AB. [6] Take HI and ſet from F to L, and draw CLM; now DM meaſured on your *Line of Chords* is 15 Deg. 2 Min. the Diſtance of the *Subſtilar Line* from the 12 *a-clock Line.*

Secondly, *For the* Stile's Height.

[1] From the Point H draw the Line HK *parallel* to CD the 12 *a-clock Line.* [2] Then take

---

† The *Sine* of an *Arch* is a Line drawn from *any Point* of the *Circumference of a Circle* to that Line that paſſes thro' the *Center* of the ſaid *Circle.*

HK in your Compaſſes, and ſet it from L to N, and draw CN for the *Top of the Stile*; [3] Then ſhall MN meaſured on your *Line of Chords* be 31 *Deg.* 49 *Min.* the *height* of the *Stile.*

Thirdly, *For the* Difference of Inclination * of Meridians.

[1] Set one Foot of your Compaſſes in M, and take the *neareſt diſtance* to EF. *This Diſtance* ſet upon the 12 *a-clock Line* from F to O. [2] Then take the *diſtance* from O to G, and ſet it from O to P. [3] Take the *diſtance* PM in your Compaſſes, and meaſure it on your *Line of Chords*, and you will find it to be 25 *Deg.* 46 *Min.* the *Inclination of Meridians* ſought: This 25 *Deg.* 46 *Min.* reduced into Time (by the *Table* III.) is 1 *Hour*, 43 *Min.* 4 *Seconds*, by which I ſee that the *ſubſtilar Line* will fall *between* the *Hours* of *one* and *two* a-clock in the *Afternoon.*

Laſtly, *For the* Hour Lines.

[1] In any *convenient* Place *in the Subſtilar Line* (according to the Largeneſs of your Dial Plane) as at M, draw the Line RS at *right Angles* to the *Subſtilar Line* CM [2] Set one Foot of your Compaſſes in M, and take the *neareſt diſtance* to CN the *Stile's height*, [3] One foot reſting in M, turn the other to q in the *Subſtilar Line*, upon q as a *Center*, with the *diſtance*

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* See *Plate* 7. *Fig.* 1, in which HI repreſents the 12 *a-clock Hour Line* in that Place, and NS is the *Line* that is *perpendicular* to the *Plane*; now the *Angle* that is made between theſe two Lines at I, is what in Dialing is called the *Inclination of Meridians*, and is an *Arch* of the *Equinoctial*, comprehended between the *Meridian* of the *Plane* and the *Meridian* of the *Place*, and ſhews in what *Longitude* from the *Meridian* of the *Plane* it will become an *Horizontal* Dial.

q M, draw *the Circle* as you ſee done in the Dial, which repreſents the *Equinoctial.*

[4] Lay a Ruler from *the Center* at q to D (that is the Place where the *Line* RS cuts the 12 *a-clock Hour Line)* and then the Ruler doth cut the *Equinoctial* in a Point *near* O, where you are to begin to divide it into 24 *equal Parts*, which I have here marked with little *Dots*. [5] Lay a Ruler to the *Center* at q, and to *every one* of the *equal Diviſions* in the *Equinoctial*, and where the Ruler cuts the *Line* RS, make theſe marks *** *Laſtly*, draw Lines from the *Center* of the Dial at C to theſe marks *** in the *Line* RS, and thoſe are the true *Hour Lines* upon the Dial, to which place the proper Figures to *every Hour*, as you ſee done in the *Scheme*.

Of the hanging *of the* Stile.

The *Stile* C N muſt hang *directly Squarewiſe* with the *Subſtilar Line* CL, and this you muſt try with your *Quadrant*, thus; place *that edge* of your *Quadrant* upon which *the Sights are*, to the *Top of the Stile*, and when the *Thread* cuts the *Limb* of the *Quadrant* in the *ſame Degree* with the *Latitude of the Place*, then it is *right* otherwiſe it is *wrong*.

Note, *Now you have finiſhed your Dial, and in ſo doing, you have in the making of this* one *made* four *Dials*, viz.

	Deg.	*Min.*
A South Declining Eaſt A South Declining Weſt A North Declining Eaſt A North Declining Weſt	21	10

But

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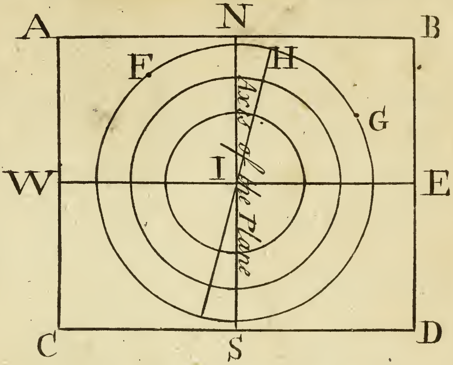
The Inſtrument for finding the Declination of a Wall &c

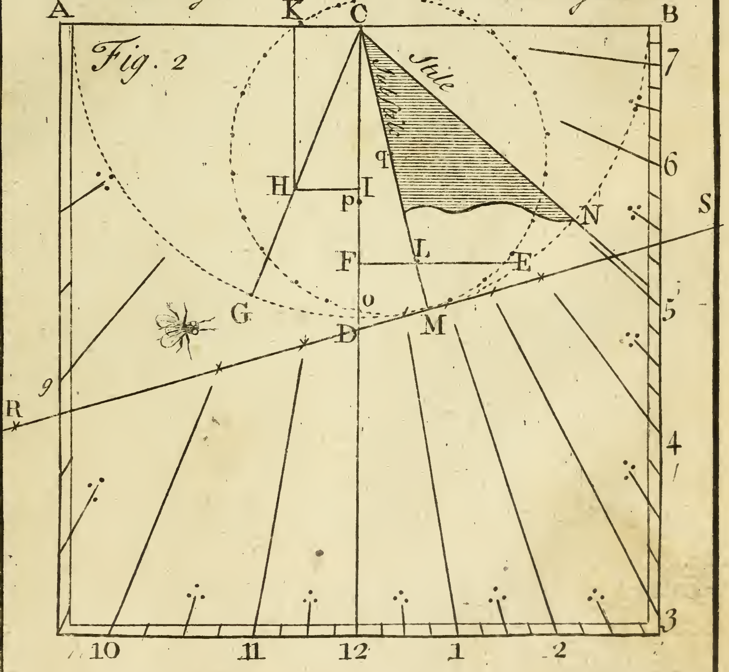
Plate 7

Fig 1


A
N
B
E
H
G
W
I
E
Axis of the Plane
C
S
D

An Erect Weſt Declining Dial

Fig. 2


A
K
C
B
Stile
Substile
7
q
6
H
I
p
N
S
F
L
E
5
o
G
D
M
9
R
4
3
10
11
12
1
2

But you muſt change the *Names* of the *Hours*, viz. 10 into 2, 9 into 3, 8 into 4, *&c.*† and place the *Stile* on the *contrary Side* of the 12 *a-clock Line* for the *South* declining *Eaſt*, and by turning the Dial *up-ſide downwards*, for the *North Decliners*, ſo that the *Stile* may point *upwards* to the *North Pole*, and the Hours about midnight omitted, as your own Reaſon will ſoon direct you.

☞ Here you are to take notice, that if the Plane *decline* 60 *Deg. or more*, then the *Hour Lines* having *Centers* will be ſo near together, and the *Stile* will then be ſo near the *Plane*, that *one* thing will much diſcommode *another*, and make it a great difficulty to ſhew the *true hour* of the Day thereby, therefore they ought to be removed *far* from the *Center*, that they may become *wide enough* to anſwer the end of ſhewing diſtinctly the true Hour of the Day.

But ſtill here will ariſe a Difficulty in *dividing the Circle*, which repreſents the *Equinoctial*, for there will be required the Difference of the *Inclination of Meridians* of the Plane and Place; for this Purpoſe I have added *Table* V. for the *Latitude* of *London*, ſhewing the *Stile's height*, *Subſtile's diſtance* from the *Meridian*, and difference of *Inclination of Meridians*, which tho' calculated indeed for the *Latitude* of *London* (*viz.* 51 *Deg.* 32 *Min.*) yet may ſerve indifferently for moſt Places in *England*; but he that wants to be more curious and exact, may, by obſerving the Directions given in the beginning of this Chapter for finding the *three Requiſites* (by that means) obtain *thoſe Requiſites* for any Place in the known World.

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† And here you are to obſerve that it is *not the Stile* that changes its *Place* or *Poſition*, but the *Plane itſelf*; for the *Stile* anſwering to the *Latitude of the Place*, it remains *always ſteady* and the ſame in *all Declinations:* ſo that if you conceive a Plane *declining* (as in the *Example* now before us) 21 *Deg.* 10 *Min.* to the *Weſtward*, the *Subſtilar Line* falls betwixt the Hours of *One* and *Two* in the Afternoon; and ſuppoſing the *ſame Plane* to move to the *Eaſtward* 21 *Deg.* 10 *Min.* the *Subſtilar Line* will then fall betwixt the Hours of *Ten* and *Eleven* in the Morning. For it is *an infallible Rule*, that if the Plane *declines Eaſtward*, the *Subſtilar Line* falls amongſt the *Morning Hours*, but if *Weſtward*, amongſt the *Afternoon Hours*.

CHAP. XII. *To make a Dial upon a Plane when the* Pole *has but a* ſmall Elevation *above the Plane.*

Plate 8. Fig. 1.

I Shall take for *an Example* a Dial that I made at *London*, whoſe Plane *declined* from the *South* by the *Eaſt*, *northerly* 100 *Deg.* 16 *Min.* that is 79 *Deg.* 44 *Min.* from the *North* towards the *Eaſt*.

For the Stile's height.

☞ The *Stile's height* you will find by *Conſtruction*, as in Chap. X. or by *Table* V. to be 6 *Deg.* 22 *Min.* the *Subſtile's diſtance* from the *Meridian*, 38 *Deg.* 1 *Min.* the *Inclination of Meridians*, 81 *Deg.* 56 *Min.* [1] Let the *Square* ABCD repreſent the Plane, becauſe 'tis a *North* Plane *declining Eaſtward*, therefore the *Stile* muſt point *upwards*, and the *Center* of the *Hour Line* will be *ſome where below* the Plane itſelf.* And therefore take 60 *Deg.* from your *Line of Chords*. Set one Foot of your Compaſſes at the *bottom Corner* of the Plane at C, and draw the *Quadrant*

---

* If the Plane had been 79 Deg. 44 Min from the *South* to the *Eaſt*, or *Weſt*, then the *Stile* muſt have pointed *downwards* towards the *South Pole*, and the *Center* of the Dial would have been ſome where *above* the *Plane* itſelf.

drant EF. [2[Take 38 *Deg.* 1 *Min.* from your *Line of Chords*, (the *Subſtile's* diſtance from the 12 *a-clock Line)* and ſet it from F to G, then draw CG *continued* for the *Subſtilar Line.* [3] Take 6 *Deg.* 22 *Min.* the *Stile's height* from your *Line of Chords*, and ſet it from G to H, and draw CH for the *Stile:* [4] Now, becauſe the *Stile* has but *ſmall height*, draw an *other Line* IK *parallel* to the *height* or top of the *Stile* of the *Dial*, at ſuch *convenient* diſtance as in your judgment will beſt fit the Dial Plane, *viz.* that all the *Hour Lines* may fall thereon, ſo ſhall that Line IK be the *enlarged Stile* of the Dial.

For the Hour Lines.

[5] Now by the *Subſtilar Line*, and this *enlarged Stile*, the *Hour Lines* may be drawn (at *convenient* diſtances) without any regard had to the *Center* of the Dial.

And to do that, aſſume any *two Points* in the *Subſtilar Line* CG, at ſome *convenient* diſtance from each other, as L and M, and through thoſe *two Points* draw *two ſtreight Lines*, both of them at *right Angles* to the *Subſtilar Line* CG, as the Lines NLO and PMQ. [6] Set one foot of the Compaſſes in L, and take the *neareſt* diſtance to the *enlarged Stile* IK, and turn that foot from the *Stile* to R; on R as a *Center* with the diſtance LR draw a *Semicircle*, ſet one foot of the Compaſſes in M, and take the *neareſt diſtance* to the *enlarged Stile* IK, and turn *that foot* from the *Stile* to S; on S, as a *Center*, draw a *Semicircle.*

[7] Take the Plane's *Inclination of Meridians*, 81 *Deg.* 56 *Min.* and ſet from L to T, and from M to V upon the *Semicircles.* † Then

---

† You muſt make the *Radius* LT, and MV, ſeverally the *Radius* of a *Line of Chords*, when you ſet off the *Inclination* of *Meridians.*

[8] Divide *each Semicircle* into 12 *equal Parts*, beginning at T and V; lay a Ruler to the *Centers* R and S *ſeverally*, and to the *Marks* juſt now made in the *Semicircles*, and the Ruler will then cut the *Lines* PMQ and NLO, in the true Places where the *Hour Lines* muſt be drawn.

Laſtly, Lay a Ruler to *thoſe Marks* in the *Lines* PMQ and NLO, and draw *right Lines* through the *Plane*, and they ſhall be the *true Hour Lines* required, and will be removed far enough from the *Center*, and that will ſhew diſtinctly the Hour of the Day.

For the Stile.

The *Stile* muſt ſtand at *right Angles* upon the *Subſtilar Line* IK. And muſt be placed as near to the wideſt diſtance of the Hour Lines as poſſible; becauſe the wider the Hour Lines are, the better may the Hour of the Day be diſcovered.

For the Quarters.

The *Quarters* are drawn by dividing *each* of the 12 *equal Parts* in the *Semicircles* into *four equal Parts more*, and from *thoſe* Diviſions draw Lines, as has been taught above for drawing the *Hour Lines*, and your Dial is finiſhed.

An Erect great Decliner

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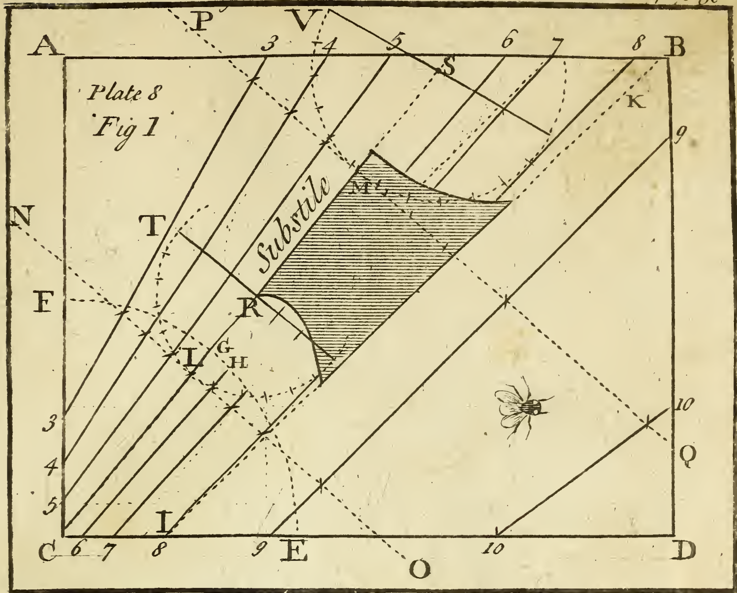
Plate 8
Fig 1
A
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T
Substile
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R
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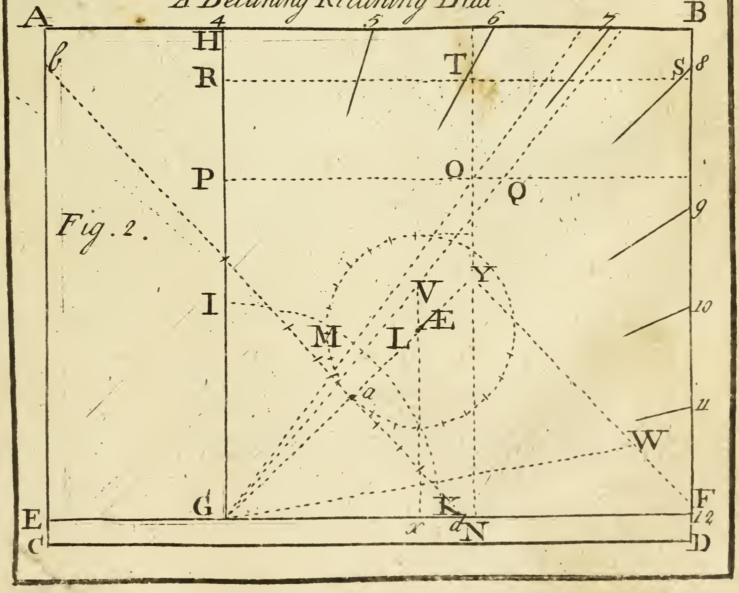
Q

A Declining Reclining Dial


A
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b
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Fig. 2.
9
I
Y
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L
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W
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K
F
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x
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N
12
C
D

CHAP. XIII. *To make a declining* reclining* *Dial.*

Plate 9. Fig. 2.

SUCH Planes as do directly face the *South* or *North Points* of the *Horizon*, but do *recline* (or fall backwards) from the *Zenith* (like the Roof of a Houſe) towards the *South* or *North*, are called *South* or *North Direct* Planes, *reclining* ſo many *Degrees* as the *Reclination* is; and the Number of *Degrees* that the Plane *reclines*, may be found by applying the *Edge* of your *Quadrant*, in which the *Sights* are placed to the *Plane*, and the *Thread* will cut the *Limb* in the *Number of Degrees* that the Plane *reclines*, which being a Thing ſo plain, I need not give any Example.

And of *reclining Planes* there are *ſix* Varieties, *three* of *South*, and *three* of *North Recliners*, all which may be reduced to *new Latitudes*, wherein they will become *Horizontal Planes*, and conſequently Dials may be made as has been taught, Chap. IV. where I have ſhewn how to draw *Hour Lines* upon an *Horizontal Plane*.

Firſt of Direct SOUTH Recliners.

Firſt Variety: Let there be a *direct South Plane* in the *Latitude* of *Cambridge*, which is 52 *Deg.* 12 *Min.* which *reclines* from the *Zenith* thereof 26 *Degrees*; in what *Latitude* will that be an *Horizontal Plane?*

---

* Thoſe *Dial Planes* that *lean from you* when you ſtand *before them*, are called *reclining Planes*, becauſe they *recline* from the *Zenith*.

Now, becauſe the *Reclination* is *leſs* than *the Complement of the Latitude* 37 *Deg.* 48 *Min. Subſtract* the Plane's *Reclination* 26 *Deg.* from the *Complement of the Latitude* 37 *Deg.* 48 *Min.* and the *Remainder* 11 *Deg.* 48 *Min.* is the *new Latitude* in which it becomes an *Horizontal Plane.*

The Operation.

	Deg.	Min
The *Complement* of the Latitude at *Cambridge* is —	37	48
The Plane's *Reclination* there (which *ſubſtract*) is —	26	00
The *new* Latitude is — — —	11	48

So that an *Horizontal Dial* made for the *Latitude* of 11 *Deg.* 48 *Min.* ſhall be a *South Recliner* 26 *Degrees* in the *Latitude* of *Cambridge.*

Second Variety. If the *Reclination* of the Plane be *equal* to the *Complement of the Latitude of the Place,* the *new Latitude* is *nothing,* that is, neither *Pole* has any *Elevation* above ſuch a *Plane,* and the *Hour Lines* are all *parellel,* and the *Stile* is likewiſe *parellel* to the *Plane itſelf*; and therefore, a Dial for ſuch a Plane muſt be made in *all Reſpects,* as has been ſhewn *Chap.* IX. *Plate* 6.

So that admit at *Lincoln,* where the *Latitude* is 53 *Deg.* 13 *Min.* a *South* Plane *reclines* from the *Zenith* 36 *Deg.* 47 *Min.* (which is equal to the *Complement of the Latitude* of that City) I ſay, it becomes an *Horizontal Dial* under the *Equinoctial,* as appears by the Operation

The Operation.

	Deg.	Min.
The *Complement* of the Latitude at *Lincoln* is — —	36	47
The Plane's *Reclination* there (which *ſubſtract*) is —	36	47
So you ſee the *new* Latitude is — —	00	00

In *Plate* 6, you have the Dial that is for this Purpoſe.

Third Variety. If the *Reclination* of the Plane *exceeds* the *Complement of the Latitude of the Place,* then *ſubſtract* the *Complement of the Latitude* from the *Plane's Reclination,* and the *Remainder* is the *new Latitude,* where it will become an *Horizontal Plane.*

Example.

Suppoſe at *Norwich,* whoſe Latitude is 52 *Deg.* 42 *Min.* a *direct South* Plane *reclining* 56 *Deg.* from the *Zenith,* where will that be an *Horizontal Dial?*

The Operation.

	Deg.	*Min.*
The Plane's *Reclination* — — —	56	00
Complement of the Latitude of *Norwich* (which *ſubſtract*) —	37	18
The *New* Latitude is — — — —	18	42

So that an *Horizontal Dial* made for the *Latitude* of 18 *Deg.* 42 *Min.* will be a *direct South reclining Dial* from the *Zenith* of *Norwich* 56 *Deg.*

Secondly, *Of Direct* NORTH Recliners.

Firſt Variety. If the *Reclination* be leſs than the *Complement of the Latitude of the Place, add* them together, and that is the *new Latitude* where *ſuch Recliner* will become an *Horizontal Plane.*

Example.

Suppoſe at *Newcaſtle upon Tyne,* whoſe Latitude is 55 *Deg.* 1 *Min.* a *direct North* Plane ſhould *recline* from the *Zenith* 29 *Deg.* how muſt the *Hour Lines* be drawn thereon?

To the *Complement of the Latitude* of *Newcaſtle upon Tyne*, 34 *Deg.* 49 *Min. add* the *Plane's Reclination* 29 *Deg.* and their *Sum* is 63 *Deg.* 49 *Min.* and that is the *new Latitude,* for which Place make an *Horizontal Dial,* as has been before taught, and that will be a *North reclining Dial,* at the Place abovementioned.

The Operation.

	Deg.	Min.
The *Complement* of the Latitude at *Newcaſtle upon Tyne* is —	34	49
The Plane's *Reclination* there (which *add)* is — — —	29	00
The *new* Latitude — — — —	63	49

Second Variety. If the *direct North* Plane *recline equal* to the *Latitude of the Place, add* it to the *Complement of the Latitude,* and *that Sum* will always be 90 *Deg.* ſo that *under the Pole* it becomes an *Horizontal Dial*; make a Dial as has been taught in *Chap.* III. *Plate* 3. *Fig.* 1. by dividing a Circle into 24 *equal Parts,* and fixing a Wire *perpendicular* in the *Center,* and it is done.

Example.

Suppoſe at *Wrexham* in *Denbighſhire,* whoſe Latitude is 53 *Deg.* 2 *Min.* a *direct North* Plane reclines 53 *Deg.* 2 *Min.* I deſire to know *where* this will become an *Horizontal Plane?*

The Operation.

	Deg.	Min.
The *Complement* of the Latitude at *Wrexham* is — —	36	58
The Plane's *Reclination* there (which *add)* is — — —	53	02
The *new* Latitude is — — — — — —	90	00

Laſtly, If the Plane's *Reclination* exceed the *Complement of the Latitude of the Place, add* them together, and *that Sum* is the *new Latitude* where *ſuch a Plane* will become an *Horizontal Plane.*

But note, if the Sum *exceed* 90 *Deg.* take the *Complement* thereof to a *Semicircle,* or 180 *Deg.* and the *Remainder* is the *new Latitude,* where ſuch a *Reclining* Plane will become *Horizontal.*

Example.

Suppoſe at *Shewsbury,* whoſe *Latitude* is 52 *Deg.* 42 *Min.* a *direct North* Plane *reclines* from the *Zenith* 60 *Deg.* where will it become an *Horizontal Plane?*

To the *Complement of the Latitude of the Place* 37 *Deg.* 18 *Min. add* the Plane's *Reclination* 60 *Deg.* and *their Sum* is 97 *Deg.* 18 *Min.* whoſe *Complement* to 180 *Deg.* is 82 *Deg.* 42 *Min. in which Latitude* ſuch a Plane at *Shrewsbury* will become *Horizontal*; therefore draw *Hour Lines* thereon, as you have been taught in making the *Horizontal Dial,* and they will be the true *Hour Lines* for that Plane and Place, as juſt now mentioned.

The Operation.

	Deg.	*Min.*
The *Complement* of Latitude at *Shrewsbury* is	37	18
The Plane's *Reclination* there (which *add*) is	60	00
The Sum (which is to be *ſubſtracted* from the *Semicircle*)	97	18
A *Semicircle* is (180 *Degrees*)	180	00
The Sum as above to be *ſubſtracted*	97	18
The *new* Latitude	82	42

Note, That in making of any of theſe *North* or *South reclining Dials,* you have alſo made (at the ſame Time) a *direct North* or *South reclining Dial* from the *Zenith,* 26 *Deg.*

As in the *firſt Variety* for *Cambridge*, you have made alſo a *North Dial inclining* to the *Horizon* 26 *Deg*. *either* by drawing of the *Hour Lines* and *Stile through the Center*, or by turning the *reclining Dial* about, *upon* the *Hour Line of Six*; and then as the *North Pole* is raiſed or elevated upon the *South Recliner*, ſo much will the *South Pole* be raiſed or elevated above the *North Incliner*.

CHAP. XIV. *To make an* Eaſt *or* Weſt Reclining* *Dial*.

AS all *North* and *South reclining* Dial-Planes were reduced to *new Latitudes*, wherein they would become *Horizontal Planes*; and thereby made by the Directions given in *Chap*. IV. ſo all DIRECT *Eaſt* or *Weſt Reclining* Dial Planes in *any Latitude*, may be reduced to *erect* or *upright* DECLINING *Planes* in *another Latitude*, and therefore may be made by the Directions in *Chap*. XI. of this Treatiſe; yet I ſhall here ſhew, for the young *Tyro*'s Improvement, how they may be done *mechanically*, without any ſuch Alteration. But firſt, to reduce them to new Latitudes.

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* As in *upright* or *erect* Dial Planes there were two Sorts of *Varieties*, *viz*. *Erect direct* and *erect Declining*; ſo there are two Sorts of *Varieties* of *Reclining* Dial Planes likewiſe; for ſuch *Reclining* Planes as do directly face either the true *Eaſt*, *Weſt*, *North*, or *South* Points of the Heavens are called DIRECT *Reclining* Planes.

Again, thoſe *Reclining* Planes which do not *directly* face the ſaid *Cardinal Points*, but deviate therefrom, *i. e.* face ſome other Points ſituate between them, as *South-Eaſt*, *North-Weſt*, *North-Eaſt*, are called DECLINING *Reclining* Planes, and the manner of drawing the *Hour Lines* upon theſe *Direct* and *Declining Reclining* Planes, affords a much greater Variety than there was in the *erect* or *upright* Planes. See Page 20.

The Rule.

The *Complement* of the *known Latitude*, or *Latitude you are in*, is always the *new Latitude*, and the *Complement* of the *Reclination** is always the *Declination* in that *new Latitude*, in which it will become an *erect declining* Plane.

And before I proceed any further it is proper to inform you how you ſhall know whether the *North* or *South Pole* is *elevated* above any given Plane.

[1] All *Horizontal Planes* in *North Latitude* have the *North Pole* elevated; but all Horizontal Planes in the *South Latitude* have the *South Pole* elevated.

[2] Upon all *erect Planes* whether *direct* or *declining*, if it face the *South*, the *South Pole* is elevated; but if it face the *North*, the *North Pole is elevated*, as you may the better perceive by viewing the *erect direct North* and *South* Dials in *Plate* 11.

[3] Upon all *direct Eaſt* and *Weſt* Planes (let them recline ever ſo far) the *North Pole* is elevated; but on their *oppoſite Incliners* the *South Pole*.

[4] Over all *North reclining Planes*, whether *direct* or *declining*, the *North Pole* is elevated; and over the *oppoſite Incliners* the *South Pole*.

Laſtly, Over all *South reclining direct* or *declining*, if the *Plane paſs between* the *Zenith* and the *Pole*, the *South Pole* is elevated, as in the *North Pole* on their *oppoſite Incliners*, and *if the Plane lie between*

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* The *Reclination* of a Plane is the Quantity of *Degrees* which any Plane, on which a Dial is ſuppoſed to be drawn, *lies or falls* back from the *truly erect* or *upright* Plane.

the Pole and the Horizon, the *North Pole is elevated*; but the *South* over their *oppoſite Incliners*.

Now let it be required to make an *Eaſt Dial* for *Worceſter*, to *recline* 40 *Degrees*.

According to the *former* Method of reducing it to *new Latitudes*, it will be an *erect Dial* in *Latitude* 37 *Deg.* 47 *Min.* (that being the *Complement of the Latitude* of *Worceſter*) *declining* from the *South Eaſtward* 50 *Degrees*, that being the ☞ *Complement of the Plane's Reclination*. So that if by the Directions in the XIth *Chapter*, you make an *erect Dial* for 37 *Deg.* 47 *Min. North* Latitude, *declining* 50 *Deg. South Eaſt*, it will be an *Eaſt Recliner* 40 *Deg.* from the *Zenith*, in the *Latitude* of 52 *Deg.* 13 *Min.* However I ſhall here ſhew how to do it *mechanically*.

Firſt, You muſt conſider, that the *Eaſt* and *Weſt* Recliners have their *Center near* the *Bottom* of the *Plane*, but the Incliners of both ſorts have their *Centers near* the *Top*: And the *Eaſt* Incliner and *Weſt* Recliner muſt have their *Centers towards* the *right Hand*; but the *Eaſt* Recliner and *Weſt* Incliner have their *Centers towards* the *left Hand*.

Theſe Things being *well underſtood*, I ſhall now proceed to practice.

Having made choice of your *Plane*, as ſuppoſe ABCD. *Plate* 8. *Fig.* 2.

For the Subſtilar Line *and* Stile's height.

According to the foregoing Directions, I obſerve that the *Center* of *this* Dial muſt be at the *Bottom* towards the *left Hand*: therefore [1] at the *Bottom* of the *Plane*, draw the *Line* EF for the 12 *a-clock*

Line, in which make choice of ſome *convenient* Place, as at G; [2] chuſe G for the *Center* of the *Dial*, and from G draw GH at *right Angles* to EF. [3] Then with one foot of the Compaſſes in G, deſcribe the *Quadrant* IK, and by the Help of your *Line of Chords*, ſet off the *Plane's Reclination* 40 *Deg*. from I to L, and draw the *Line* GL *as long as you can*, [4] *Alſo* ſet off from I to M the *Complement of the Latitude of the Place* 37 *Deg*. 47 *Min*. and draw the *Line* GM *as long as you can*: [5] then in *any* Point at Pleaſure in the 12 *a-clock Line* EF, chuſe a *Point* as N, and from that *Point* draw a Line *parallel* to GH, as NO; and through the Point where it *cuts* the *Line* GM, draw PO *parallel* to EF; [6] take GQ in your Compaſſes, and ſet it from G to R, and draw RS *parallel* to the *Meridian* EF, and it will cut NO, in T; [7] ſet *the Diſtance* PQ from G to V, and draw VX *parallel* to TN; [8] take in your Compaſſes GX, and ſet it from T to Y, and draw GY for the *Subſtile*; [9] from Y *erect the perpendicular* YW (take VX in your Compaſſes, and ſet it from Y to W) and draw GW for the *Stile*: The *Triangle* GYW, repreſenting the *Stile* of your Dial, which being erected *perpendicular* to the *Plane*, upon the *Subſtile* GY, ſhall give the *Hour* by the Shadow of its *upper* edge.

For the Hour Lines.

[1] Chuſe a *Point* at Pleaſure in the *Subſtile* GY, as at *a*; through *that* at *right Angles* thereto, draw the *Line* *b a*, *as long as you can*; ſet one foot of the Compaſſes in *a*, *viz*. the *Point* where the *Line* *b a* cuts the *Subſtile*, and take the *neareſt diſtance* to the *Stile's height*; let *one* foot reſt in *a*, and turn the *other* to Æ in the *Subſtile*, and on Æ as a *Center* de-

ſcribe the *Semicirle* (or a whole *Circle* if you pleaſe). [2] Lay a Ruler to the *Center* of the *Circle* at Æ, and to *d*, that is, where the *Line b a* cuts the 12 *a-clock Line* GF, and where the Ruler cuts the *Circle*, there you are to begin to divide it into 24 *equal* Parts: a Ruler laid to Æ, and to the *equal* Parts in the *Circle*, will cut the *Line b a* into *unequal* Parts, *where* make *Marks**** *Laſtly*, A Ruler laid to the *Center* of the Dial at G, and to thoſe *Marks**** in the *Line b a*, will be the true *Hour Lines* required.

The *Line* GF being the 12 *a-clock Line*, you muſt place 12 at the *end*, as you ſee in the *Figure*, and the reſt 11. 10. 9. 8. 7. 6. and then your Dial is finiſhed.

N.B. In drawing *this* Dial, you have made *three more*; for if it is *turned upſide down*, then it is a *Weſt* Dial *inclining* 40 *Degrees*, with *this Alteration only*, that where 11 *now* ſtands you muſt place 1, and 2 where 10 is, &c. and *conſequently* the *Subſtile* will *then* be as much on the *right Hand*, as it is *now* on the *left*.

If it were drawn upon *oiled Paper*, the *back-ſide* would be a *Weſt* Dial, *reclining* 40 *Deg*. *only* the Figures 12. 10. 9. &c. muſt be 1. 2. 3. &c.

Laſtly, If the 12 *a-clock Line* G F be *turned upwards*, the *back-ſide* will be an *Eaſt* Dial *inclining* 40 *Deg*. and the Figures muſt remain juſt as they are; *only* the *Subſtile* muſt be *as far* to the *left Hand* of the *perpendicular* G H, as it is *now* on the *right*.

to Fould out Facing page 49

A North or South Declining Inclining Dial

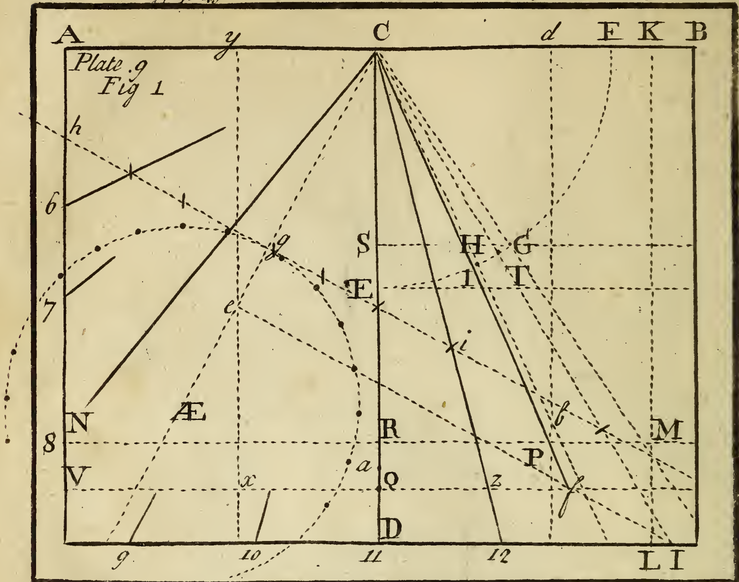

Plate 9
Fig 1

A
y
C
d
E
K
B
h
6
7
8
N
V
Æ
g
S
H
G
Æ
I
T
e
i
b
M
R
P
a
Q
x
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f
D
9
10
11
12
L
I

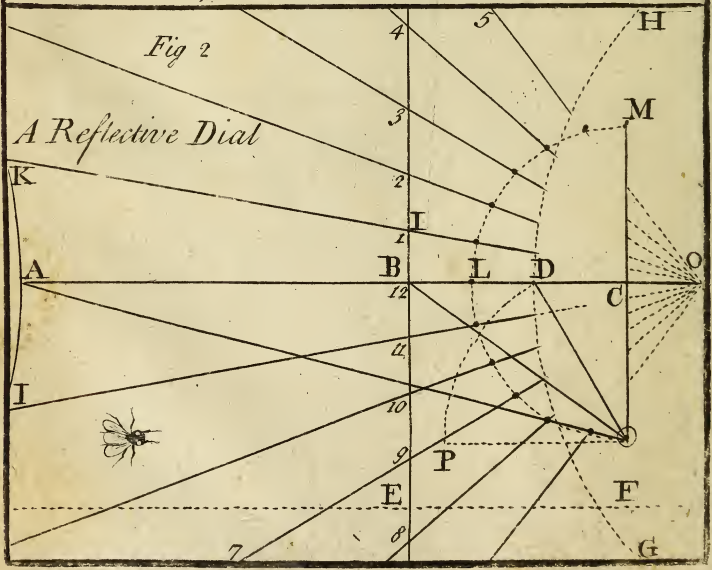

Fig 2

A Reflective Dial

4
5
H
3
M
K
2
I
1
A
B
L
D
O
C
12
11
I
10
9
P
E
F
8
7
G

CHAP. XV. *To make a* North *or* South *Declining** Reclining *or* Inclining *Dial*.

Plate 9. Fig. 1.

THESE *Dial Planes* cannot be reduced to *new Latitudes* without the help of *Trigonometry*, therefore I ſhall proceed *Mechanically*.

Take for an *Example* a Plane at *Edinburgh declining* from the *South* to the *Eaſt* 30 *Deg*. and *reclining* from the *Zenith* 25 *Deg*.

Firſt for the Stile.

[1] Draw the *Horizontal Line* AB; [2] make choice of any *convenient* Place in the Line AB, as C, for a *Center*, and draw CD. [3] With your *Line of Chords* of 60 *Deg*. draw the *Quadrant* FF. [4] Take the *Complement of the Latitude of Edinburgh* 34 *Deg*. 3 *Min*. from your *Line of Chords*, and ſet it from E, to G, and draw the Line CG *as long as you can*. [5] Take the Plane's *Declination* 30 *Deg*. from your *Line of Chords*, and ſet it from E to H, and draw the Line CH, *as long as you can*. [6] Take the *Inclination of the Plane* 25 *Deg*. from your *Line of Chords*, and ſet it from E to I, and draw the Line CI *as long as you can*. [7] Make choice of a Point in the Line AB as K, and draw KL *parallel* to CD, and it cuts the Line CG *(the Complement of the Latitude)* in M, and thro' that *croſſing* draw MN *parallel* to AB,

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* Thoſe Dial Planes that *lean towards you* when you ſtand *before them* are called *Inclining*, and thoſe that *lean from you* are called *Reclining*; and *Declining*, *Reclining* or *Inclining* Dials, are thoſe whoſe Planes *neither* face *directly* any of the *four Cardinal Points*; nor are they either *perpendicular* or *parallel* to the *Horizon*.

and it *cuts* the *Line of Inclination* CI in P. [8] Take CP, and ſet it from C to Q, draw QV *parallel* to AB. [9] Take RP in your Compaſſes, and ſet it from C to S, and draw SH *parallel* to AB, to cut the *Line of Declination* CH in H. [10] Take CK in your Compaſſes, and ſet it upon the *Line of Declination* from C to T, and draw ET *parallel* to AB. [11] Take ET in your Compaſſes, and ſet it from Q to X, and draw XY *parallel* to CD. [12] Now take in your Compaſſes the *diſtance* SH (that is from CD to the *Line of Declination)* and ſet it from Q to Z, and draw CZ for the *Meridian Line*, or *Hour Line* of 12. [13] Take in your Compaſſes the *diſtance* CS, place *one* Foot in E, and make a Mark where the *other* Foot falls at *a*. [14] Take C *a*, and ſet it from C to *b* upon the *Line of Inclination*, and draw *bd parallel* to CD. [15] Take in your Compaſſes C*d*, carry *that* extent, and ſet *one* Foot of the Compaſſes in X, and the *other* will give *e*, draw C*e* for the *Subſtile*, from *e* erect the *Perpendicular ef*. [16] Take *bd*, and ſet it from *e*, to *f* and draw the Line C *f* for the *Stile*, ſo ſhall the *Triangle* C*ef* be the *Stile* to be erected *Perpendicular* to the Line C *e* the *Subſtile*. The Side C*f*, being *parallel* to the *Axis* of the World, and by its *Shadow* is determined the *Hour of the Day*.

For the Hour Lines.

[1] Chuſe a Point in the *Subſtile* C *e*, as *g*, thro' which Point, and at *right Angles* to the *Subſtile*, draw the Line *g h*. [2] Set *one* Foot of the Compaſſes in *g*, and take the *neareſt Diſtance* to the Line C*f*, and turn *that* Foot about to Æ; upon Æ with the *Diſtance* Æ*g*, draw the *Equinoctial Circle*, or ſo much of it as will ſuffice to bring the *Hour Lines* up-

on the Plane that you have Occaſion for. [3] Lay a Ruler to the *Center* at Æ, and to *i*, that is, where the Line *h i* cuts the *Meridian* or 12 *a-clock Line*, and there begin to divide the *Equinoctial Circle* into 24 *equal Parts*; a Ruler laid to Æ and to thoſe *equal Parts*, will divide the Line *hih unequally*, and give the Places thro' which the *Hour Lines* muſt paſs: *Laſtly*, Lines drawn from the *Center* of the Dial at C, thro' thoſe *Marks* in the Line *hi*, ſhall be the *true Hour Lines* of *that* Dial; which *Number* as you ſee done in the Figure.

Note, *You may draw your Dial with* Charcoal *or* Black-lead *(that is, the* Preparative Work) *that it may be taken out when you have put on the* Hour Lines, *ſo that nothing may appear but what is really uſeful.*

All other *Declining Reclining* Dials are made by *the ſame Directions* that are given *in this* above, only by *changing* the *Figures*, &c.

As *Secondly*, The *Incliner*, *Declining* from the *South Weſtward*, is made by *the ſame Directions*, only the *Quadrant* muſt be drawn on the *other ſide* towards A, which may be beſt conceived by ſuppoſing *this* Dial to be drawn on *oiled Paper*; and looking thro' the Paper, that which on the right ſide of the Paper was an *Inclining* Dial, *declining* from the *South Eaſtward*, will be an *Inclining* Dial, *declining* from the *South Weſtward*.

Thirdly, A *North Declining Eaſt Recliner* is the ſame with a *South Decliner Eaſt*, *Reclining* from the *Zenith*, only the *Horizontal Line* muſt be at the *Bottom* of the Dial; and alſo the *Center* of the *Quadrant* (which is the *Center* of the *Hour Lines)* muſt be *above* the Line AB, and towards the *left Hand*,

and may be repreſented by a *South Declining Eaſt* Recliner, turned *Bottom* upwards, with the *ſame ſide* towards you as before.

Fourthly, A *North Declining Weſt* Recliner is the ſame with a *South Declining Weſt* Incliner, only (as before) the *Horizontal Line* AB, muſt be at the *Bottom* together with the *Center* of the Dial, and the *Quadrant* muſt be *above the Line*, and towards the *right Hand*, and may be repreſented by the Dial already deſcribed, if imagined to be done upon *oiled Paper*, and ſeen thro', being turned *Bottom upwards*.

N. B. *The* Hours *on the* North Dials *muſt be* numbered *the* contrary way *to thoſe of the* South Dials.

CHAP. XVI. *To make a* Reflective * *Dial.*

Plate 9. Fig. 2.

THIS Dial will ſhew the true Hour of the Day by *Reflection* on a *Cieling*, where the *direct* Beams of the Sun can never come, and it will repreſent the *Sun's Motion*, as truly and regularly *within the Houſe*, as his natural Motion is *without*, provided *the Window* open to the *Southward*, or ſo that the Sun might ſhine in or near it.

Theſe ſorts of Dials are grounded upon this Principle in *Opticks*, viz. *that the Angle of* INCIDENCE *is equal to the Angle of* REFLECTION: *that is*, whatever *height* the Sun be at any Time, the *ſame height* has the *reflected Spot* upon the Cieling.

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* *Reflective* or *reflecting* Dials are made by a little piece of Looking-Glaſs duly placed, which reflect the *Sun's Rays* to the top of a Cieling where the Dial is drawn. *N. B.* The Piece of Glaſs ſhould be as thin as it can well be ground.

This being underſtood, it is eaſy to draw *Hour Lines* upon the *Cieling* of a Room, or upon any other Place though never ſo Irregular; and that the *Hour* by the help of a *Piece* of a *Looking-Glaſs* fixt *Horizontally* in a *Window*, or ſome other *convenient Place* for that Purpoſe, may be truly known.

To place the Glaſs.

[1] Having then made choice of a *Window* towards the *South*, that ſo you may have as much of the *Morning* and *Afternoon* Sun as poſſible, take ſpecial care to fix your Glaſs *Horizontal*, otherwiſe your Work will all be ſpoiled.

N. B. All *Great Circles*, as *Equinoctial* and *Hour Circles*, are *ſtreight Lines*, and the *leſſer Circles*, as *Tropicks* and other *Parallels of the Sun's Declination*, are* *Conick Sections:* and that *this* Dial (when drawn) is no other than a *Horizontal Dial* for the *ſame Latitude inverted*, Plate 9. Fig. 2.

To draw the 12 a-clock Hour Line.

[2] Having then placed a Piece of a *Looking-Glaſs* about the *bigneſs* of a *Sixpence*, marked thus ⊙ in the *Figure*. Over this *Glaſs* hang a *Plumb Line* at 12 *a-clock*, this String will caſt a true *Meridian Line (i.e.* it is the true 12 *a-clock Hour Line)* upon the Floor.

Or if you think that way too difficult, you may find a 12 *a-clock Line* as I have taught in Chap. IV. page 19 and 20. This being done, the 12 *a-clock Line on the Floor*, is to be *transfer'd* to the *Cieling*, which may be performed by the Help of *two* Plumb Lines, *one* held *over the Glaſs* ⊙, and the *other* held *over*

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* A *Cone* doth ſomewhat reſemble a *Sugar-Loaf*, and being cut any where *ſlope-wiſe* is called a *Conic Section.*

the other end of the 12 *a-clock Line* at A, at the other end of the Room; by this means you will have *two* points on the *Cieling*, juſt over your 12 *a-clock Line* on the *Floor*, to which *two* Points on the *Cieling* ſtretch *a Line* blacked with *Lamb-Black and Oil*, and holding it faſt at both Ends, (as two *Sawyers* or *Carpenters* generally do a CHALKED LINE) ſtrike the *black* 12 *a-clock Line* on the *Cieling*, repreſented by AC.

To draw the Equinoctial.

[3] Make the *Angle* B⊙P, equal to the *Complement of the Latitude of the Place*, as ſuppoſe at *Ormſkirk* 36 *Deg.* 30 *Min.* which you muſt do *by a String*, held *one* end to *the Glaſs* ⊙, and the *other* to the *Cieling* repreſented by B⊙, and applying the *Edge* of your *Quadrant*, till you find the *String and Plummet*, cut the *Limb* at 36 *Deg.* 30 *Min.* thro' *that Point* of the 12 *a-clock Line*; at B the *Equinoctial Circle* muſt paſs, which draw at *right Angles* to the 12 *a-clock Line* AD, and it is a *ſtreight Line* as you ſee in the Figure.

To draw the Tropick *of* Cancer.

[4] Then becauſe the Sun's *greateſt height at* 12 *at Noon*, at *Ormskirk* is 59 *Deg.* 59 *Min.* make the *Angle* D⊙P *equal thereto* by help of your *Quadrant and String* as before: ſo is the *Point* D, the *Point* in the 12 *a-clock Line*, where the *Tropick of Cancer* muſt paſs, which, becauſe it is a *leſſer Circle* of the *Sphere*, it is not a *ſtreight Line* but a *Curve* which muſt be drawn by help of Table VI; (that is by having the Sun's height at every Hour the 21ſt of *June* for the Latitude of your Place;) ſo with an even hand, you may draw the *Tropick of Cancer* GDH.

To draw the Tropic *of* Capricorn.

[5] Becauſe the Sun's *leaſt height at* 12 *at Noon* at *Ormskirk* is 13 *Deg.* 1 *Min.* make the *Angle* A⊙P *equal thereto*, by help of your *Quadrant and String*, ſo ſhall A be the *Point* in the 12 *a-clock Hour Line* on the *Cieling* where the *Tropick of Capricorn* muſt paſs, and muſt be drawn by the *Table* of the *Sun's Altitude* at *every Hour*, upon the 21ſt of *December* as above directed, ſo that ⊙ D repreſents the *reflected Ray* on the *longeſt Day*; ⊙ B, when he is in the *Equinoctial*, that is *twice a Year*, viz. on *March* 22d, and *September* 21ſt, and ⊙ A repreſents the *reflected Ray* on the *ſhorteſt Day*.

To draw the Hour Lines.

[6] With any *convenient* opening of your Compaſſes, draw the *Semicircle* ⊙ L M, and *divide it* into 12 *equal Parts*, becauſe 15 *Deg.* in the *Equinoctial* is *equal* to *one Hour in Time*, as by Table III.

Hence, becauſe the *Center* of the *Dial* doth not fall *in the room*, but *out of it* in the open Air at O, for which Reaſon (before the *Hour Lines* can be drawn) you muſt find the *Angle* that *each Hour Line* makes with the 12 *a-clock Hour Line*, their *Complements* are what they make with the *Equinoctial*; this is eaſily done by *Calculation*, but becauſe I have throughout this Treatiſe laid that Method aſide, and kept ſtrictly to a *Mechanick Method*, your beſt Way will now be to draw an *Horizontal Dial* for the *Latitude* of *Ormſkirk*, which is 53 *Deg.* 30 *Min.* as has been taught in Chap. IV. and with your *Compaſſes* and *Line of Chords* meaſure the *Angles* that the *Hour Lines* make with the *Meridian*, and ſet them down as followeth.

Hours.		*Angles with the Meridian.*		*Angles with the Equinoct.*	
12		0	0	0	0
1	11	12	10	77	50
2	10	24	54	65	6
3	9	38	47	51	13
4	8	54	19	35	41
5	7	71	34	18	26
6		90	00	00	00

Then with your *Quadrant* lay it to the 12 *a-clock Hour Line*, and *make Angles there* upon the *Cieling equal* to thoſe in the *ſecond Column*; or elſe you may lay it to the *Equinoctial Line* on the *Cieling*, and make the *Angles* of *every Hour* equal to thoſe in the *third Column* of this *Table*, and by the help of your *blacked String*, as before directed, draw the *Hour Lines* upon the *Cieling*, which ſhall be the *true Hour Lines* required.

Another *Way to draw the* Hour Lines.

Or if you think this way *too tedious*, when you have your *Horizontal Dial* fitted to *your Latitude*, place the *Center* of your *Horizontal Dial* in the *Center of the Glaſs*, and fix *a Thread* in the *Center of the Dial*; lay the *Thread* ſtreight over *every Hour* of your *Horizontal Dial*, faſten it at the *other ſide* of the *Room*; and ſo transfer them to the *Cieling*, as was ſhewn in drawing the 12 *a-clock Line from the Floor* by help of the *Plumb Lines*; thus have I given you *two* Methods by which you may draw the *Hour Lines* on the Cieling, which I leave to the judicious Practitioner to make uſe of which he pleaſes.

To make a Table for drawing the Hour Lines.

The framing of a *Table* of the *Angles* that the *Hour Lines* make with the 12 *a-clock Hour Line* and *Equinoctial*, is made after this manner, *viz.* Suppoſe I would meaſure the Angle D⊙P in Plate 9. Fig. 2. Take your Compaſſes and extend on the *Line of Chords* from *the End of the Line* at O to 60

Deg. with *that extent* ſet *one* foot in ⊙, and draw the *Arch* P D; take the ſaid *Arch* P D in your Compaſſes, and apply it to your *Line of Chords,* and you will find it to contain 59 *Deg.* 59 *Min.* and ſuch is the *Angle* D ⊙ P. And after the ſame manner is *any other Angle* meaſured.

CHAP. XVII. *To make a* Refracted * *Dial.*

FOR this purpoſe you muſt have in readineſs an *Horizontal Dial* for the *Latitude of your Place,* and then ſtick up a *Pin* or *Wire,* or aſſign any Point in any *hollow Bowl,* or *Diſh,* to ſhew *the Hour,* and make that the *Center* of your *Horizontal Dial*; then fix upon any Place on the *Edges* of the *Bowl,* or *Diſh,* for the 12 *a-clock Hour Line,* and *transfer* the reſt of the *Hour Lines* from the *Horizontal Dial* to the *Edge* of the *Bowl*; and taking away the *Horizontal Dial,* hold up a String from *the End* of the *ſaid Pin* faſtened thereto, *over* the 12 *a-clock Hour Line* equal to *the Latitude* of your Habitation; and this is done by applying the *Edge* of your *Quadrant* to the *String,* 'till it *cuts* the *Latitude of the Place* upon the *Limb* thereof.

Then with *a Candle,* by bringing the *Thread* to caſt *a Shadow* on any *Hour Point,* juſt before marked upon the *Edge* of the *Bowl, that* Shade in the *Bowl* is the Place to which the *true Hour Line* muſt be drawn; and if the Bowl be full of *Water,* or *any other Liquor,* when the *Hour Lines* are drawn, it will never ſhew the *true Hour* by the Shadow of the Top of the Pin, but when the Bowl is filled again with the ſame Liquor.

---

* *Refracted Dials* are ſuch as ſhew the *true Hour* only by means of ſome *refracting* tranſparent Fluid, ſuch as *Water,* &c.

For more particular Satisfaction, ſee my *Aſtronomy* under the Word *Refraction*, Vol. I. Page 38.

CHAP. XVIII. *To make a* Globe *Dial.*

Plate 10. Fig. 1.

THIS Dial is drawn upon a *ſolid Ball* or *Globe*, and ſhews the *Hour* of the Day without a *Stile* or *Gnomon*.

The manner *of turning* round Balls, is well known to Workmen; but if a large *Stone Ball* is to be made, that cannot be turned becauſe of its *Weight*.

You muſt therefore in the firſt Place form it *globular* with a *Chiſſel*, and then take a wooden or braſs *Semicircle* (as in Fig. 2.) of *the ſame* Diameter, as you deſign *your Ball* (the bigger the better;) this being done, turn the *Semicircle* about the Ball, and take away all the *Superfluities* with a *Raſp*, until the *Semicircle every where*, and *every way*, juſt touches the *Superficies* thereof; afterwards make it ſmooth with a *Pumice Stone*, or *Sea Dog's Fiſh Skin*.

For the Circles of the Sphere.

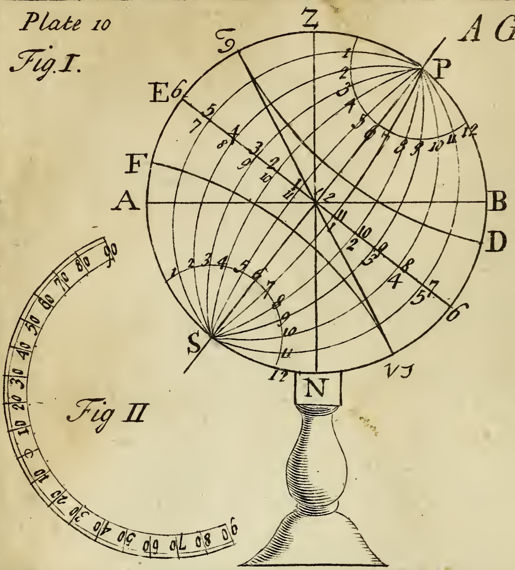
The Globe being thus finiſhed, and ſet in your Garden upon a *Pedeſtal*, as Fig. 1, proceed to draw thereon *the Circles of the Sphere* (by help of a Pair of *ſpheric Compaſſes*, or a *Semicircle* that juſt fits *the Globe)* as AB the *Horizon* ZN the *prime Vertical*, ſo ſhall Z be your *Zenith*, and N your *Nadir*.

to Fold out facing page 59

Plate 10

A Globe Dial

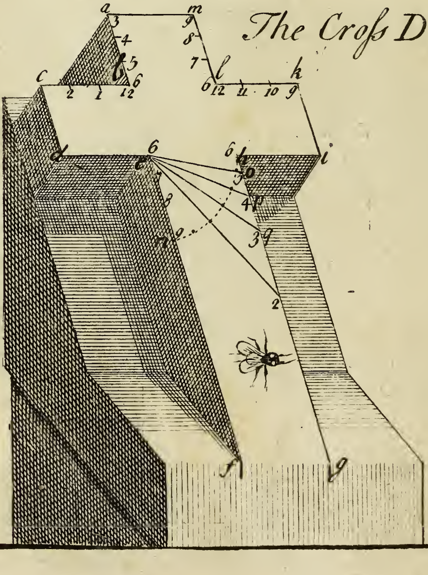
Fig. I.



Z
P
E 6
F
A
B
D
S
N
VI
Fig II

Fig III

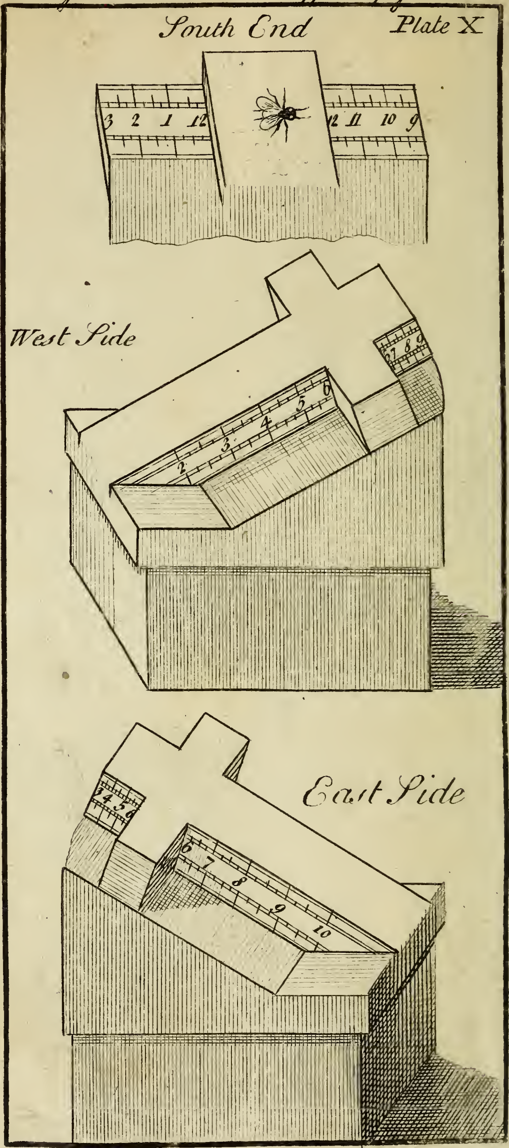
The Croſs Dial



a
m
c
l
k
d
e
h
i
o
p
q
n
f
g

The Croſs Dial view'd in three different poſitions

Plate X


South End
3 2 1 12
12 11 10 9
West Side
2 3 4 5 6
7 8 9
East Side
3 4 5 6
6 7 8 9 10

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Draw PS for the *Earth's Axis* to *any Latitude*, as *ſuppoſe* that of *Dublin* 53 *Deg.* 16 *Min.* ſo ſhall P be the *North Pole*, and S the *South Pole* of the World. Make Z Æ *equal* to SP, and draw Æ æ for the *Equinoctial*, which *divide* into 24 *equal Parts*, and draw the *Hour Circles* or *Meridians* all meeting in the *Poles* of the World.

Your *Semicircle* being divided into 180 Deg. and *numbered* as you ſee in Fig. 2. mark 23 *Deg.* 29 *Min.* from the *Equinoctial* at Æ to ♋ and F, and draw ♋ D for the *Tropic of Cancer*; and F ♑ for the *Tropic of Capricorn*; alſo from the *Poles* at P and S mark (by help of your *Semicircle*) 23 *Deg.* 29 *Min.* and draw the two *Polar Circles*; 12, 12. *Laſtly*, Draw ♋♑ for the *Ecliptic*, and thereon place the 12 *Signs of the Zodiac*, beginning at the *Equinoctial*, where the *Ecliptic* cuts it with ♈; at 30 *Degrees* further, place ♉, at 30 *Degrees* from that, ♊, at 30 *Degrees* more, put ♋, which will be where the *Ecliptic* cuts the *Tropic of Cancer*, and ſo on, at every 30 *Degrees* in the *Ecliptic*, place the *Signs* in order thus, ♌♍♎♏♐♑♒♓. I have omitted them in the Figure to avoid Confuſion.

For the placing *of the* Hours.

The *Hours* muſt be *numbered* in the *Equinoctial*, placing 12 at the *Eaſt* and *Weſt Points* of the *Horizon*, and 6 upon the *Meridian*. Then becauſe *one half* of the *Globe* (nearly) is illuminated when the Sun ſhines, and the *other half* remains in *Darkneſs*, and ſo the *Extremity* of the *Light* ſhews the *Hour* in two *oppoſite* Places.

If moreover the *different Countries* on the *Earth's Superficies*, as likewiſe the *principal Cities* were laid down upon the *Globe*, according to their *true Lati-*

tudes and *Longitudes,* you may diſcover any Moment the Sun ſhines upon the ſame, by the *illuminated Part* thereof, what Places on the Earth *are enlightened,* and what Places *are in Darkneſs.* The *Extremity of the Shadow* ſhews likewiſe what Places the *Sun* is *Riſing* or *Setting* at; and *what Places* have *long Days; theſe* with many more *curious Problems* are ſeen at one View, too many to be enumerated in this Place.

This Dial is the *moſt natural* of all others, becauſe it reſembles *the Earth itſelf,* and the *exact* manner of *the Sun's ſhining* thereon.

Note, You may draw as many *Parallels of Declination* upon it as you pleaſe, by the *Table* of the *Sun's Declination.* See Table I.

Alſo if *two Wires* be put in, *one* at P and *another* at S, and 12 at the *Meridian,* and the *Hours numbered* as you ſee, *that Wire* at P, will give the *Hour* in the *Summer,* andthat at S the Hour in the *Winter.*

CHAP. XIX. *To make a* Croſs *Dial, a* Star *Dial, and a* Window *Dial.*

Plate 10. Fig. 3.

A *Croſs Dial* is that which ſhews the *true Hour* of the Day without a *Stile,* by the *Shadow of one Part* of the Dial itſelf, appearing upon *another Part thereof.*

There is one of *this* ſort of Dials near the *South-Weſt* Corner of *Middle Moorfields, London.**

For

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* The *Inſcription* upon this Dial being cut in *Iron,* and expoſed to the Weather, it is ſo defaced, that it required much Pains and Art to render it legible, and therefore I deſire the Reader's Excuſe for preſerving

For the making of this Sort *of* Dial.

You need have no regard to the *Latitude of the Place,* for that is to be conſidered in the *placing,* and not in the *making* of it.

[1] In order to which, prepare a Piece of *Wood* or *Stone* of what Size you pleaſe, and ſhape it in the *Form* of a *Croſs,* ſo that *ab, bc, cd, de, eh, hi, ik, kl, lm,* and *m a* may be *all equal: ef,* may be *more than double* to *a e:* that in *London* is 25 Inches, and 5 Tenths of an Inch *long* from *a* to *f,* and *a m* is 4 Inches and 8 Tenths, *ef* 15 Inches and 8 Tenths, and the *Depth* or *Thickneſs* is 6 Inches, 8 Tenths. This premiſed:

[2] Set one Foot of your Compaſſes in *e,* and draw the *Arch* or *Quadrant h n,* which *divide* into *ſix equal Parts,* for *ſix Hours,* becauſe it is a *Quarter of a Circle* lay a Ruler from the *Center e,* and draw *eo, ep, eq.*

[3] Now the *Poſition* of this Dial being ſuch that *its End a m,* muſt *face* the *South,* and the *upper Part* of it to lie *parallel* with the *Equinoctial,* the *Sun* at 12 *a-clock* will ſhine juſt *along the Line ab* and *ml.* Therefore you muſt place 12 at *b* and *l,* then it is plain that from 12 to 3 *the Shadow* of *the Corner a* will paſs *along the Line bc;* therefore take from the *Quadrant* juſt now drawn *hn the Diſtance ho,* and ſet it from 12 to 1.

[4] Take alſo *hp,* and ſet from 12 to 2, *hq* being equal to *bc,* at *c* place 3, where the *Shadow* of the *Corner a* goes *quite off the Dial at c,* or 3 in the *Afternoon;* but then *the Shadow* of the *Corner i,*

ſerving it. "*This Dial was placed here as a Boundary of the Pariſh of* St. Stephen, Coleman-Street, *in the memorable Year* 1706, *and in the fifth Year of the glorious Reign of our moſt gracious Sovereign Queen* Anne, *whom GOD long preſerve,* Robert Trevitt, *Painter,* Fecit."

will come on *the Side hg* at *q*, or 3 a-clock, where place the Figure 3; at *p* 4, at *o* 5, and at *h* 6 in the *very Corner:* becauſe at 6 the Sun will ſhine *right along* the Line *ih*; place 6 alſo at *the Corner l*, becauſe the Sun at 6 ſhines *right along* the Line *ik*, and from 6 till 9 (if it be in a *Latitude* where the Sun continues up ſo late at Night) the *Shadow* of the *Corner* at *k* is paſſing *along* the Line *lm*.

[5] Therefore take in your Compaſſes the *Diſtance ho*, and ſet from 6 to 7.

[6] Take *hp*, and ſet from 6 to 8 along the Line *lm*; and the *Diſtance hq* is *equal* to *lm*; therefore at *the Corner m*, place 9 becauſe the *Shadow* of the *Corner k*, *goes off* the Line *lm* at 9.

[7] Then for the *Morning Hours* the *Shadow* of the *Point c* will enter upon the Line *ab* at the *Point a*, juſt at 3 in *the Morning*; therefore *draw* Lines from 7 and 8 in the Line *lm*, which let be drawn *parallel* to *am*, and having placed 3 at the *Corner a*, place 4 right againſt 8, 5 againſt 7, ſo will 6 be in *the Corner b*, becauſe at 6 the Sun ſhines juſt along the Line *cb*, and from 6 till 9 the *Shadow* of the *Point d* is paſſing along the Side *ef*.

[8] Therefore having placed 6 in *the Corner e*, *draw Lines* from the Points *opq*, parallel to *di*, and at *thoſe Points* put the Figures 7, 8, 9, for when *the Shadow* of the *Point d* comes to 9, the *Shadow* of the *Point m* is at the *Point k*, and from 9 to 12 the *Shadow* of *m* paſſeth along the Line *kl*, and at 12 the *Shadow* of *m*, is come to *l*.

[9] *Therefore* take the *Diſtances ho*, *hp*, *hq*, and ſet them from *l*, to 11 and 10, the *Diſtance hq* being *juſt equal* to *lk*, and thus is the Dial finiſhed.

The Sun as it *goes off* from *one Part* of it *comes on* to *another Part* thereof; ſo that the Time of the Day

Figure 3. Is a Horizontal Dial, & shews the position of the Hour Lines, according as the Dial Plain is either a Square, Circle &c. —

Fig. 3

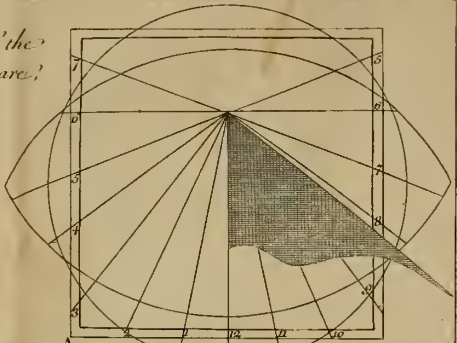

1
5
0
6
5
7
4
8
3
9
2
1
12
11
10

Fig. 2

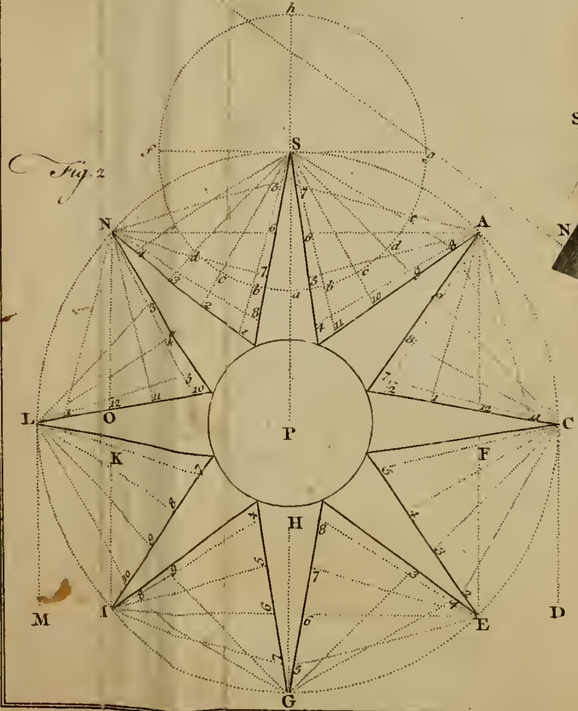
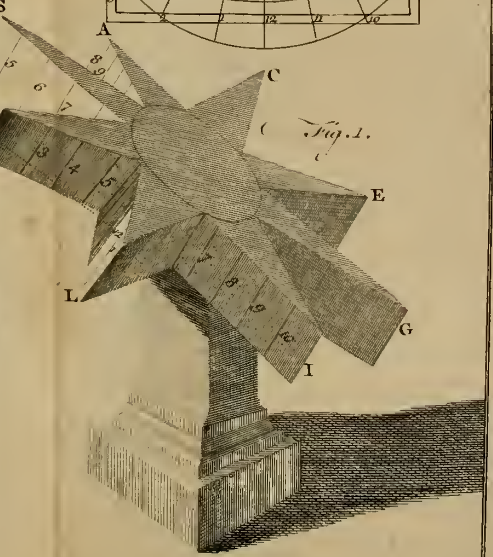

h
f
g
S
N
A
a
b
c
d
e
L
O
P
C
K
F
H
M
I
E
D
G

Fig. 1



J. Barlow Sculp.

Day may *always* be found upon *ſome Part* or *other* of it, when the Sun ſhineth.

The Reaſon why theſe Dials require *Thickneſs*, as well as other *Dimenſions*, is becauſe being placed *parallel to the Equinoctial*, the Sun ſhines upon the *upper Face* all the *Summer*, and on the *longeſt Day* is *elevated* 23 *Deg.* 29 *Min. above* the Plane of the Dial, and *conſequently* the *Shadow* of *a* will fall at *Noon* in the *Line ab*, and not in *the Point b*, but at an *Angle of* 23 *Deg.* 29 *Min.* therewith, (that being the Sun's greateſt Declination on the longeſt Day.) And on the *ſhorteſt Day* the *Shadow* of *a*, will be *below* the Plane or Line *ab*, and make an *Angle* of 23 *Deg.* 29 *Min.*

This Dial is *univerſal*, for when you have made one, according to the above Directions, there is nothing to do but to fix it in your Garden, *&c.* by help of your *Quadrant*, to the *Elevation of the Equinoctial*, or *Complement of the Latitude of your Habitation*, and ſo that the Side *ab* may *exactly* face the *South*.

If you would place this Dial in any place *within the Polar Circles*, you muſt then make all the *Ends* of an *equal* length, *viz. ef*, &c. *equal* to *ab*; otherwiſe, the Shadow would quit one Side before it comes on another, as you may the better perceive by viewing the Figure in Plate X. Fig. 3.

Of the STAR DIAL.

Plate XB.

This is an *Equinoctial Dial*, made in the *Form* of a *Star*, having eight *Rays* or *Points*, but *no Stile*, the *Thickneſs* of the *Ends* of the *Rays* (being perpendicular to the Surface of the Dial) performing the *Office* of the *Stile* in a *common Equinoctial Dial*, by caſting their *Shadows* on the *Sides* of the *Rays* or *Points*.

The only Dial we have ſeen of this kind is of the following Dimenſions. The *Radius* of the outer *imaginary Circle* PS (Plate XB. Fig. 2.) is 7 Inches, and that of the inner Circle P*x*, 2 Inches and 1 quarter; and the *Thickneſs* of it 2 Inches and a half. But in order to aſſiſt the Reader's Imagination in forming a true Idea of this Dial, we have given a *perſpective View* of it on *Plate* XB Fig 1. in which the *Hour Lines* on the Rays S N L I G are diſtinctly ſeen; and the ſame is to be underſtood of the other Rays, whoſe Sides cannot be ſeen in this View. *Note*, the ſame Rays in both figures are marked with ſame Letters.

The *Conſtruction* of this Dial is the *ſame* with that of the *Equinoctial Dial*, explained in Chap. III. Page 15. The *only Difference* being, that inſtead of *one Stile*, which is there placed in the Center of the Dial, the *End* of *each Ray performs the Office of a Stile*, and therefore the *whole* is properly a *Compoſition of eight Dials*; ſome of theſe Stiles ſhew *one Hour*, and ſome *another*. Thus the *Stile*, or *End of the Ray* S, will, in the Morning, caſt its Shadow on the *Side of the Ray* A, and *there* ſhew the Hours 8, 9, 10, 11; at *Noon* it will caſt *no Shadow*; but in the *Afternoon* its Shadow will be projected on the *Side* of N, and ſhew the Hours 1, 2, 3, 4. The *Stile* or End of the Ray A, will, by caſting its Shadow againſt the *ſide* of C, ſhew the Hours 11, 12, 1, 2. At *three* it will caſt *no ſhadow*; but afterwards its Shadow will be projected on the *ſide* of S, and there ſhew the Hours 4, 5, 6, 7. The *ſame* is to be *underſtood*

derſtood of the *reſt of the Rays,* and is ſufficiently plain from the Figure. For as the *eight Rays* are at *equal Diſtances* from each other, they face the *Eight principal Points of the Compaſs.* That is, the Ray S faces the *South,* A the *South-Weſt,* C the *Weſt,* E the *North-Weſt,* G the *North,* I the *North-Eaſt,* L the *Eaſt,* and N the *South-Eaſt.* And as the Sun is, with regard to the *Equinoctial, directly South* at *Noon, South-Weſt* at three, *Weſt* at ſix, *North Weſt* at nine, *North* at *midnight, North-Eaſt* at three in *the Morning, Eaſt* at ſix, and *South-Eaſt,* at nine; therefore the Rays reſpecting thoſe Points, will then caſt no Shadow. That is, the Ray L at *ſix in the Morning* will caſt no Shadow, *both Sides* of the Ray being at that Time equally illuminated. The ſame is to be underſtood of all the reſt.

In order to *conſtruct* this Dial, divide the outer Circle S, C, G, L, (Plate X. B. Fig. 2) into *eight* equal parts, and having deſcribed a ſmall concentric Circle P *x* H, draw the *eight Rays* S, A, C, E, G, I, L, N, as you ſee in the figure. Then make choice of one of the Rays to face the South, which in the Figure is that marked S. On S, the Point of this Ray, with the *Radius* of your Line of Chords deſcribe a Circle, as *a g h f*; then will S *a* be the *meridian Line.* From *a* ſet off 15 Degrees both ways towards *b,* and alſo from *b* to *c,* from *c* to *d,* and from *d* to *e.* From S, through *b, c, d, e,* draw Lines both ways, till they *cut* the *Sides of the next Rays* A and N, which will give the *Hour Lines.* Thoſe on A, becauſe to the Weſtward of the Meridian Line, will be 8, 9, 10, 11, and thoſe on N, being to the Eaſtward of it, 1, 2, 3, 4. The very ſame Method muſt be purſued with regard to the reſt of the Rays; obſerving that all their *Meridian Lines* muſt be *parallel to the firſt,* S *a.*

Thus

Thus AB is the *Meridian Line* of A, CD of C, EF of E, GH of G, IK of I, LM of L, and NO of N. Having thus found the Places of all the *Hour Lines* on the *Projection*, transfer them to the *correſpondent Rays* of the *real Dial*, and draw Lines *perpendicular to the Surface*, or *parallel to the Ends of the Rays*, which will be the *Hour Lines* required as you ſee in the *Perſpective View* of the Dial on Plate X.B. Fig. 1.

Having thus *transfer'd* the *Hour Lines* from the *Projection* to your *Dial*, nothing remains but to *fix* it in a *true Poſition*. That is, to *fix it ſo*, that its *Surface be parallel to the Equinoctial*, and the *Ray* S *point directly to the South*, or to *the Sun when he is in the Meridian*. This Poſition is the ſame with that of the *Equinoctial Dial*, deſcribed in Chap. III. Page 15, where the Reader will find ſufficient Inſtructions for this Purpoſe.

Thus having in the foregoing Work ſhewn how to make all manner of uſeful Dials, I think it only remains now to ſhew how

To make a WINDOW *Dial.*

By this Dial, you may know the Hour of the Day tho' the Sun *doth not ſhine out bright*, but appears ever ſo little thro' the Clouds: And ſo you may in the Night by the *Stars*, and *Moon*.

If your Window face any Point of *the Compaſs* (*near* the *South* is beſt) then find its *Declination*, as has been taught in Chap. X. then procure a large Sheet of thick writing Paper, and thereon make the Draught of your Dial (as taught in Chap. XI.) which done, either with *Wax* or a few ſmall *Nails*, faſten your *Paper Draught* to the Plane (which I ſuppoſe to be made ready for that Purpoſe) upon which you deſign to draw the Dial. Having placed *the Center* of your *Paper* Dial in *the very Place* where you deſign to fix the *Stile* in the Plane, there faſten a String, and with this *String* (or a *Ruler*) transfer the *Hours* and *Quarters* from your *Paper Draught* upon the *Window*. And this you will find to be a very eaſy, expeditious, and exact Way of drawing the *Hour Lines* and *Quarters* upon any Plane whatſoever. Then get an *Iron Rod* about *the Thickneſs* of your *Hour Lines*, and nail it to the Window Frame *exactly* in *that Place* where the *Center* of your *Paper Draught* was placed, and ſet it to the *Latitude of your Place* by help of your *Quadrant* which is done by putting *that Edge* of it to the *Stile* wherein the *Sights* are, and raiſing the *Stile* higher or lower till the Thread cuts *the Limb* in the *Degree of the Latitude of your Place*; and there faſten it at *right Angles* over the *Subſtile Line*.

You may put Figures (or any Marks for your own Information) to the *Hour Lines*, and thus is your Dial finiſhed: and, how pleaſant this will be, to ſit in your Houſe, &c. to ſee the Time of the Day that the Sun ſhines upon the Window, will beſt appear from the Dial when thus made: ſince at any time when you can ſee the Sun juſt *thro' the Clouds* you may then tell the Hour of the Day as well as if it ſhone *ever ſo bright*; for look thro' the *Window*, and take the Stile *between your Eye and the Sun*, and at the ſame Time you'll ſee the Hour where the *Stile's* ſhade will fall upon the Window, and that is the true Hour of the Day. *Alſo*, in the night you may do the ſame by any *known Star*, by firſt knowing the Time the Star will be upon the *Meridian* or *South*, and as much as it wants of the *South* by the Dial *ſubſtracted* from the Time of *Southing*, gives the *true Hour* of *the Night*, but if it be *paſt* the *South* by the Dial, *add* ſo much to the Time of *Southing*, and you have the Time of the *Night*. The ſame Method is to be uſed for the Time of the Night by the *Moon*.

This Method of *transferring* the *Hour Lines* from your *paper draught*, is what you may uſe in making of any Dial, which I recommend as being moſt practicable.

TABLE I.

A TABLE of the *Sun's Declination* exactly calculated for the Year 1764, which (for the Uſe of Dialling) will ſerve for this Age without any ſenſible Error.

	Jan.		*Feb.*		*Mar.*		*April*		*May*		*June*	
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
1	23 S	00	17 S	02	7 S	30	4 N	37	15 N	08	22 N	05
2	22	55	16	45	7	07	5	00	15	26	22	13
3	22	49	16	27	6	44	5	23	15	43	22	21
4	22	43	16	09	6	21	5	46	16	01	22	28
5	22	36	15	51	5	58	6	09	16	18	22	35
6	22	29	15	32	5	34	6	31	16	35	22	41
7	22	22	15	14	5	11	6	54	16	52	22	47
8	22	14	14	55	4	48	7	16	17	08	22	53
9	22	05	14	36	4	24	7	39	17	24	22	58
10	21	56	14	16	4	01	8	01	17	40	23	01
11	21	47	13	56	3	37	8	23	17	56	23	07
12	21	37	13	36	3	14	8	45	18	11	23	11
13	21	27	13	16	2	50	9	07	18	26	23	15
14	21	16	12	56	2	27	9	28	18	40	23	18
15	21	05	12	35	2	03	9	50	18	55	23	21
16	20	54	12	15	1	39	10	11	19	09	23	23
17	20	42	11	54	1	15	10	32	19	22	23	25
18	20	30	11	33	0	52	10	53	19	36	23	26
19	20	18	11	11	0	28	11	14	19	48	23	27
20	20	05	10	50	0	04	11	35	20	01	23	28
21	19	51	10	28	0 N	19	11	55	20	13	23	29
22	19	38	10	06	0	43	12	15	20	25	23	29
23	19	24	9	44	1	07	12	35	20	37	23	28
24	19	09	9	22	1	30	12	55	20	48	23	27
25	18	54	9	00	1	54	13	15	20	59	23	25
26	18	39	8	37	2	17	13	34	21	10	23	24
27	18	24	8	15	2	41	13	53	21	20	23	21
28	18	08	7	52	3	04	14	12	21	30	23	19
29	17	52	——	——	3	27	14	31	21	39	23	16
30	17	36	——	——	3	51	14	50	21	48	23	12
31	17	19	——	——	4	14	——	——	21	57	——	——

TABLE I.

A TABLE of the *Sun's Declination* exactly calculated for the Year 1764, which (for the Uſe of Dialling) will ſerve for this Age without any ſenſible Error.

	July		*Aug.*		*Sept.*		*Octob.*		*Novem.*		*Decemb.*	
	D.	M	D.	M.	D.	M	D.	M.	D.	M.	D.	M
1	23 N	08	18 N	02	8 N	10	3 S	15	14 S	31	21 S	53
2	23	04	17	47	7	54	3	38	14	50	22	02
3	22	59	17	31	7	32	4	01	15	09	22	10
4	22	54	17	15	7	10	4	24	15	28	22	18
5	22	49	16	59	6	47	4	48	15	46	22	26
6	22	43	16	43	6	25	5	11	16	04	22	33
7	22	37	16	26	6	03	5	34	16	22	22	40
8	22	30	16	09	5	40	5	57	16	40	22	47
9	22	23	15	52	5	17	6	20	16	57	22	53
10	22	16	15	34	4	55	6	43	17	14	22	58
11	22	08	15	17	4	32	7	05	17	31	23	03
12	22	00	14	59	4	09	7	28	17	47	23	08
13	21	51	14	40	3	46	7	51	18	03	23	12
14	21	42	14	22	3	23	8	13	18	19	23	16
15	21	33	14	03	2	59	8	35	18	34	23	19
16	21	23	13	44	2	36	8	58	18	49	23	22
17	21	13	13	25	2	13	9	20	19	04	23	24
18	21	03	13	06	1	50	9	42	19	19	23	26
19	20	52	12	46	1	26	10	03	19	33	23	27
20	20	41	12	27	1	03	10	25	19	46	23	28
21	20	30	12	07	0	40	10	47	20	00	23	29
22	20	18	11	47	0	16	11	08	20	13	23	29
23	20	06	11	26	0 S	07	11	29	20	25	23	28
24	19	53	11	06	0	31	11	50	20	38	23	27
25	19	40	10	45	0	54	12	11	20	50	23	25
26	19	27	10	24	1	18	12	32	21	01	23	23
27	19	14	10	03	1	41	12	52	21	12	23	21
28	19	00	9	42	2	04	13	12	21	23	23	18
29	18	46	9	21	2	28	13	32	21	33	23	15
30	18	32	8	59	2	51	13	52	21	43	23	11
31	18	17	8	38	—	—	14	12	—	—	23	06

THE

EXPLANATION *and* USE

Of the foregoing

TABLE.

THIS Table ſhews you the *Sun's Declination* * every Day *at Noon*, and is exactly calculated to the Year 1764 to the *Meridian* of *London*, which will ſerve for *this Age near enough* for any Purpoſe in *Dialling*.

Note, D ſtands for Degrees, M for Minutes, N for *North* Declination, and S for *South*.

It is of good uſe to find the *Latitude of the Place* of your Habitation: this may be done by taking the height of the Sun at *Noon* with your *Quadrant*: and if the *Sun's Declination* be *South*, ADD it to the *Altitude* or Height at *Noon*, but if it be *North* SUBSTRACT: the Sum or Difference is the *height* of the *Equinoctial* or *Complement of the Latitude* in the *Northen* Hemiſphere, but in the *Southern* uſe the contrary Titles.

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* The *Declination of the Sun*, is his *Diſtance* from the *Equinoctial*, and in all Things of *this kind* the *Sun* is ſuppoſed to move *parallel* to the *Equinoctial* all *that* Day, and tho' it does not ſo in fact, yet it ſerves in Dialling *near enough* the Truth; and this *Declination* never exceeds 23 *Deg.* 29 *Min.* as appears by the Table.

Example.

Example.

Admit you are at a certain Place in the *North* of *England, &c.* and upon the 14th of *February* you obſerve the *Sun's height* at *Noon* with your *Quadrant* to be 22 *Deg.* 37 *Min.* what is the *Latitude of Obſervation?*

Operation.

	Deg.	Min.
To the *Sun's Altitude* obſerved	22	37
Add the *Sun's Declination* S.	12	56
Sum is the *height of the Equinoctial*	35	33
Subſtract it from a *Quadrant* or	90	00
The Latitude of the Place *North* is	54	27

Example 2.

	Deg.	Min.
From the *Sun's Altitude* obſerved	44	51
Subſtract the *Sun's Declination* North	10	53
Remains the *Complement of the Latitude*	33	58
Subſtract from a *Quadrant* or	90	00
Remains the *Latitude North*	56	02

TABLE II.

A TABLE of the *Equation of Time* for *Regulating* Pendulum Clocks and Watches by a Sun Dial.

Days	Jan. M.		Jan. S.	Feb. M.		Feb. S.	Mar. M.		Mar. S	Apr. M.		Apr. S	May M.		May S.	June M.		June S
1	4	Watch	6	14		13	12		48	4		1	3		8	2		4
2	4		34	14		20	12		36	3		43	3		16	2		3
3	5		2	14		27	12		23	3		25	3		23	2		29
4	5		30	14		32	12		9	3		6	3		30	2		19
5	5		57	14		37	11		55	2		48	3		36	2		9
6	6	too faſt.	24	14		41	11		41	2	Watch	30	3		42	1	Watch	59
7	6		50	14		44	11		26	2		13	3		47	1		48
8	7		16	14		47	11		11	1		55	3		51	1		37
9	7		41	14		48	10		56	1		38	3		55	1		26
10	8		6	14		49	10		40	1		21	3		58	1		14
11	8		30	14	Watch	49	10	Watch	24	1	too faſt.	4	4	Watch	0	1	too ſlow.	2
12	8		59	14		48	10		7	0		48	4		2	0		50
13	9		22	14		47	9		50	0		32	4		4	0		38
14	9		44	14		44	9		33	0		16	4		5	0		26
15	10		5	14		41	9		16	0	**	1	4		5	0		13
16	10		26	14		37	8		58	0	**	14	4		5	0	*	1
17	10		46	14	too faſt.	33	8	too faſt.	40	0	Watch	29	4	too ſlow	4	0	* Watch	12
18	11		5	14		28	8		22	0		43	4		2	0		25
19	11		24	14		22	8		4	0		57	4		0	0		38
20	11		42	14		15	7		46	1		11	3		58	0		50
21	11		59	14		8	7		27	1	too ſlow.	24	3		55	1	too faſt.	3
22	12		15	14		0	7		9	1		37	3		51	1		16
23	12		30	13		52	6		50	1		49	3		47	1		29
24	12		45	13		43	6		31	2		1	3		42	1		42
25	12		59	13		33	6		13	2		12	3		37	1		55
26	13		12	13		22	5		54	2		23	3		31	2		7
27	13		24	13		12	5		35	2		33	3		25	2		20
28	13		36	13		0	5		16	2		43	3		18	2		32
29	13		46	. . .	. . .	. . .	4		57	2		52	3		11	2		44
30	13		56	. . .	. . .	. . .	4		39	3		0	3		3	2		56
31	14		5				4		20				2		55			

TABLE II.

A TABLE of the *Equation of Time* for *Regulating* Pendulum Clocks and Watches by a Sun Dial.

Days	July			Aug.			Sep.			Oct.			Nov.			Dec.		
	M.		S.	M.		S.	M.		S.	M.		S.	M.		S.	M.		S.
1	3		8	5		46	0	Watch	18	10		23	16		13	10		32
2	3		19	5		42	0		36	10		42	16		13	10		9
3	3		31	5		31	0		55	11		0	16		13	9		45
4	3		42	5		33	1		14	11		18	16		12	9		20
5	3		52	5		28	1		34	11		36	16		10	8		55
6	4		2	5		22	1	too ſlow.	54	11		53	16		8	8		29
7	4		12	5		15	2		14	12		10	16		4	8		3
8	4		22	5		8	2		34	12		27	16		0	7		37
9	4		31	5		0	2		54	12		43	15		54	7		10
10	4		40	4		52	3		14	12		58	15		48	6		42
11	4	Watch	48	4		43	3		35	13	Watch	13	15	Watch	41	6		14
12	4		56	4		34	3		55	13		28	15		34	5		46
13	5		4	4		24	4		16	13		42	15		25	5		18
14	5		11	4		13	4		37	13		56	15		16	4		49
15	5		17	4		2	4		58	14		9	15		6	4		19
16	5	too faſt.	23	3		50	5		19	14	too ſlow	22	14	too ſlow	55	3	Watch too	50
17	5		29	3		38	5		40	14		33	14		43	3		20
18	5		34	3		26	6		1	14		45	14		30	2		51
19	5		39	3		12	6		22	14		56	14		16	2		21
20	5		43	2		59	6		42	15		6	14		2	1		51
21	5		46	2	Watch	45	7		3	15		15	13		46	1	ſlow	20
22	5		49	2		30	7		24	15		24	13		30	0		50
23	5		51	2		15	7		44	15		32	13		13	0	*	20
24	5		53	2		0	8		5	15		40	12		56	0	*	10
25	5		54	1		44	8		25	15		46	12		38	0		40
26	5		55	1	too faſt.	28	8		45	15		52	12		18	1	Watchtoofaſt	10
27	5		55	1		11	9		5	15		58	11		58	1		40
28	5		54	0		54	9		25	16		2	11		38	2		10
29	5		53	0		36	9		45	16		6	11		17	2		39
30	5		51	0		19	10		4	16		9	10		55	3		8
31	5		49	0	*	1				16		11				3		37

THE
EXPLANATION *and* USE
Of the foregoing
TABLE.

THIS is a Table of *Equation of Time*, that is, it ſhews you what the Sun *gains* or *loſes* of the Pendulum Clock *every Day*; for the *Pendulum Clock* keeps *equal Time* all the Year round, tho' the *Sun* doth not do ſo, but is *very unequal* in its Motion, *ſomtimes too faſt*, and at other Times *too ſlow*, as the Table plainly ſhews; ſo that if at any Time you want to ſet your *Clock* or *Watch* by your *Sun-Dial* you muſt look into this Table, and obſerve what the *Equation* is on that Day, and ſet it accordingly, ſo many *Minutes* and *Seconds*, faſter or ſlower, as you ſee the Clock is *too faſt* or *too ſlow* for the *Sun*.

For Inſtance, January 14 at *Noon*, I ſee the *Clock* is 9 *Min.* 44 *Seconds too faſt* for the *Sun, &c.* therefore the Clock ſhould be ſet 9 Min. 44 Seconds *faſter* than a Sun Dial.

On *May* the 10th, at Noon the Clock is 3 Min. 58 Seconds, too *ſlow*; therefore when it is *twelve* by a Sun Dial, the Clock muſt be ſet to 56 Min. 2 Seconds *after Eleven*.

TABLE III.

A TABLE for converting *Hours* and *Minutes* of *Time* into *Degrees* and *Minutes* of the *Equinoctial*; and for the turning of *Degrees* and *Minutes* of the *Equinoctial* into *Hours* and *Minutes* of *Time*.

H	°	'	°	'	'	°	'	'	°	'
'	'	''	'	''	''	'	''	''	'	''
''	''	'''	''	'''	'''	''	'''	'''	''	'''
1	15	1	0	15	21	5	15	41	10	15
2	30	2	0	30	22	5	30	42	10	30
3	45	3	0	45	23	5	45	43	10	45
4	60	4	1	0	24	6	0	44	11	0
5	75	5	1	15	25	6	15	45	11	15
6	90	6	1	30	26	6	30	46	11	30
7	105	7	1	45	27	6	45	47	11	45
8	120	8	2	0	28	7	0	48	12	0
9	135	9	2	15	29	7	15	49	12	15
10	150	10	2	30	30	7	30	50	12	30
11	165	11	2	45	31	7	45	51	12	45
12	180	12	3	0	32	8	0	52	13	0
13	195	13	3	15	33	8	15	53	13	15
14	210	14	3	30	34	8	30	54	13	30
15	225	15	3	45	35	8	45	55	13	45
16	240	16	4	0	36	9	0	56	14	0
17	255	17	4	15	37	9	15	57	14	15
18	270	18	4	30	38	9	30	58	14	30
19	285	19	4	45	39	9	45	59	14	45
20	300	20	5	0	40	10	0	60	15	0
21	315									
22	330									
23	345									
24	360									

Note		ſtand for	
	H		Hours
	°		Degrees
	'		Minutes
	''		Seconds
	'''		Thirds

THE

EXPLANATION *and* USE

Of the foregoing

TABLE.

THIS Table ſhews how to convert *Time into Motion*, and *Motion into Time*; as ſuppoſe I had 5 *Hours* 13 *Min.* 29 *Seconds* to be turned into *Degrees* and *Minutes* of the *Equinoctial*, i. e. into *Motion*; the *Operation* ſtands thus.

			D.	M.	S.	
5	*Hours*	=	75	0	0	add
13	*Minutes*	=	3	15	0	
29	*Seconds*	=	0	7	15	
The *Sum*	— —	— —	78	22	15	for anſwer.

Again, ſuppoſe I would turn 78 *Deg.* 22 *Min.* 15 *Seconds* into *Time*, then the work will ſtand *thus*.

			H.	M.	S.	
Degrees	75	=	5	0	0	add
Degrees	3	=	0	12	0	
Minutes	15	=	0	1	0	
Minutes	7	=	0	1	28	
Seconds	15	=	0	0	1	
The *Sum*	— —	—	5	14	29	for anſwer.

N. B. There being the *ſame* Number, either of *Minutes, Seconds* or *Thirds* in *an Hour*, as there are *Minutes, Seconds* or *Thirds* in a *Degree*; therefore the *Head* of each Column in the Table is marked with *three* different Characters, that the *ſame Column* might ſerve for *either*, Thus againſt 12 in the *third* Column (marked at the Top with ′,″,‴,) ſtands 3. 0. in the *Fourth* Column, and ſignifies either 3 *Degrees*, 3 *Minutes*, or 3 *Seconds* according as the *firſt* ſignified either 12 *Minutes*, 12 *Seconds*, or 12 *Thirds*, and the ſame is to be underſtood of the reſt.

TABLE IV.

A TABLE of *Meridional Angles*, ſhewing the *Degrees* of each *Hour Line* from 12 *a-clock*, upon all *Horizontal* and *North* and *South* Erect Direct *Reclining* and *Inclining Dials*, from the *Equinoctial* to the *Poles*.

Hor. Dial Lat.	XI I		X II		IX III		VIII IV		VII V		VI		South Dial Lat.
	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	
0	0	00	0	00	0	00	0	00	0	00	00	0	90
1	0	16	0	34	1	00	1	44	3	44	90	0	89
2	0	32	1	9	2	00	3	27	7	25	90	0	88
3	0	48	1	44	3	00	5	11	11	3	90	0	87
4	1	5	2	19	4	00	6	54	14	36	90	0	86
5	1	20	2	52	4	58	8	35	18	1	90	0	85
6	1	36	3	27	5	58	10	16	21	19	90	0	84
7	1	52	4	3	6	57	11	55	24	27	90	0	83
8	2	8	4	37	7	55	13	33	27	23	90	0	82
9	2	23	5	9	8	54	15	10	30	17	90	0	81
10	2	40	5	43	9	51	16	44	32	55	90	0	80
11	2	55	6	17	10	48	18	17	35	27	90	0	79
12	3	11	6	51	11	45	19	40	37	49	90	0	78
13	3	27	7	24	12	41	21	17	40	1	90	0	77
14	3	43	7	57	13	36	22	44	42	4	90	0	76
15	3	58	8	30	14	31	24	0	44	0	90	0	75
16	4	13	9	2	15	25	25	31	45	49	90	0	74
17	4	29	9	35	16	26	26	52	47	27	90	0	73
18	4	44	10	8	17	10	28	9	49	4	90	0	72
19	4	59	10	39	18	2	29	25	50	33	90	0	71
20	5	14	11	10	18	53	30	39	51	55	90	0	70
21	5	29	11	41	19	44	31	50	53	9	90	0	69
22	5	44	12	12	20	32	32	58	54	21	90	0	68
23	5	59	12	43	21	20	34	5	55	30	90	0	67
24	6	14	13	13	22	8	35	10	56	37	90	0	66
25	6	28	13	43	22	55	36	12	57	34	90	0	65
26	6	42	14	12	23	40	37	13	58	34	90	0	64
27	6	56	14	41	24	25	38	11	59	27	90	0	63
28	7	10	15	10	25	9	39	7	60	17	90	0	62
29	7	24	15	40	25	52	40	2	61	4	90	0	61
30	7	38	16	6	26	33	40	54	61	49	90	0	60

TABLE IV.

A TABLE of *Meridional Angles*, ſhewing the *Degrees* of each *Hour Line* from 12 *a-clock*, upon all *Horizontal* and *North* and *South* Erect Direct *Reclining* and *Inclining Dials*, from the *Equinoctial* to the *Poles*.

Hor. Dial Lat.	XI I		X II		IX III		VIII IV		VII V		VI		South Dial Lat.
	D.	M	D.	M.	D.	M.	D.	M.	D.	M.	D.	M.	
31	7	50	16	34	27	15	41	44	62	30	90	0	59
32	8	5	17	1	27	55	42	30	63	11	90	0	58
33	8	19	17	27	28	34	43	20	63	49	90	0	57
34	8	31	17	54	29	13	44	5	64	24	90	0	56
35	8	44	18	20	29	50	44	49	64	58	90	0	55
36	8	57	18	49	30	27	45	31	65	30	90	0	54
37	9	10	19	9	31	2	46	12	66	10	90	0	53
38	9	22	19	34	31	37	46	50	66	29	90	0	52
39	9	34	19	58	32	11	47	28	66	56	90	0	51
40	9	45	20	21	32	44	48	7	67	21	90	0	50
41	9	57	20	44	33	16	48	39	67	47	90	0	49
42	10	10	21	7	33	46	49	12	68	11	90	0	48
43	10	22	21	29	34	18	49	44	68	33	90	0	47
44	10	32	21	51	34	47	50	10	68	54	90	0	46
45	10	44	22	12	35	17	50	46	69	15	90	0	45
46	10	54	22	33	35	44	51	15	69	35	90	0	44
47	11	5	22	53	36	11	51	42	69	53	90	0	43
48	11	16	23	13	36	37	52	9	70	11	90	0	42
49	11	25	23	33	37	3	52	35	70	28	90	0	41
50	11	35	23	52	37	28	53	0	70	43	90	0	40
51	11	45	24	9	37	52	53	24	70	59	90	0	39
52	11	55	24	27	38	15	53	46	71	13	90	0	38
53	12	5	24	43	38	37	54	12	71	28	90	0	37
54	12	13	25	2	38	58	54	29	71	41	90	0	36
55	12	22	25	18	39	19	54	49	71	54	90	0	35
56	12	32	25	34	39	40	55	9	72	5	90	0	34
57	12	40	25	50	39	50	55	28	72	17	90	0	33
58	12	45	26	5	40	1	55	45	72	28	90	0	32
59	12	56	26	20	40	36	56	3	72	38	90	0	31
60	13	4	26	34	40	54	56	19	72	48	90	0	30

TABLE IV.

A Table of *Meridional Angles* ſhewing the **Degrees** of each *Hour Line* from 12 *a clock*, upon all *Horizontal* and *North* and *South* Erect Direct *Reclining* and *Inclining* Dials, from the *Equinoctial* to the *Poles*.

Hor. Dial Lat.	XI	I	X	II	IX	III	VIII	IV	VII	V	VI		Vert. Dial Lat.
	D.	M.	D.	M	D.	M.	D.	M.	D.	M.	D.	M.	
61	13	11	26	47	41	10	56	34	72	58	90	0	29
62	13	19	27	1	41	21	56	49	73	7	90	0	28
63	13	26	27	13	41	42	57	3	73	15	90	0	27
64	13	32	27	25	41	57	57	17	73	24	90	0	26
65	13	36	27	37	42	15	57	30	73	32	90	0	25
66	13	46	27	49	42	25	57	43	73	39	90	0	24
67	13	51	27	59	42	38	57	54	73	46	90	0	23
68	13	57	28	9	43	50	58	5	73	53	90	0	22
69	14	3	28	19	43	2	58	16	73	59	90	0	21
70	14	7	28	29	43	13	58	26	74	5	90	0	20
71	14	13	28	37	43	19	58	35	74	11	90	0	19
72	14	18	28	46	43	24	58	54	74	16	90	0	18
73	14	22	28	54	43	36	58	52	74	20	90	0	17
74	14	27	29	2	43	52	59	00	74	25	90	0	16
75	14	30	29	7	44	00	59	7	74	30	90	0	15
76	14	33	29	15	44	8	59	15	74	34	90	0	14
77	14	37	29	21	44	14	59	22	74	37	90	0	13
78	14	41	29	27	44	22	59	27	74	40	90	0	12
79	14	44	29	32	44	28	59	32	74	44	90	0	11
80	14	47	29	37	44	34	59	37	74	47	90	0	10
81	14	49	29	41	44	37	59	40	74	49	90	0	9
82	14	51	29	45	44	40	59	44	74	51	90	0	8
83	14	53	29	49	44	44	59	47	74	53	90	0	7
84	14	55	29	52	44	48	59	51	74	55	90	0	6
85	14	56	29	54	44	53	59	54	74	57	90	0	5
86	14	57	29	55	44	55	59	55	74	58	90	0	4
87	14	58	29	56	44	56	59	56	74	58	90	0	3
88	14	59	29	57	44	57	59	58	74	59	90	0	2
89	14	59	29	58	44	58	59	59	74	59	90	0	1
90	15	00	30	00	44	00	60	00	75	00	90	0	0

THE
EXPLANATION *and* USE

Of the foregoing

TABLE.

THIS is a Table of *Meridional Angles*; the *firſt Column* is the *Latitude*, which ſerves for an *Horizontal Dial*, and the *laſt Column* is the *Complement of the Latitude*, and is for making *Erect Direct* South or North Dials, and are thus to be uſed:

☞ Suppoſe in the *Latitude* of 53 *Deg.* I would make an *Horizontal*, and alſo an *Erect Direct* South Dial.

Firſt, *For the* Horizontal *Dial.*

See Plate 3. Fig. 2.

Now (altho' this be projected for a *higher* Latitude, yet it may ſerve our Turn here well enough to ſhew how to uſe the Table:) I look into the Table, and find againſt 53 *Deg.* and under 11 and 1 a-clock 12 *Deg.* 5 *Min.* Take this 12 *Deg.* 5 *Min.* in your Compaſſes (from the *Line of Chords*, that you draw the *Quadrant* AB by) and ſet *one* foot in the *Meridian* CA, and turning the *other* each Way, it ſhall give the *Points* where the *Hour Lines* of 1 and 11 muſt paſs; under 10 and 2, and againſt the *ſame Latitude* 53, I find 24 *Deg.* 43 *Min.* which take from the *Line of Chords*, and ſet *each Way* from the

Meridian as before, and it gives the 10 and 2 *a-clock Hour Lines.* For the Hours 9 and 3 you muſt take 38 *Deg.* 37 *Min.* for 8 and 4 a-clock, you muſt ſet 54 *Deg.* 12 *Min.* and for 5 and 7 ſet 71 *Deg.* 28 *Min.* the *Chord* of 90 gives the 6 a-clock *Hour Line,* and ſo by drawing *Hour Lines* from the Center *thro'* theſe Points, thus ſet off in the *Arch* AB, are the true *Hour Lines* required.

Secondly, *For the Erect Direct* South *Dial.*

See Plate 4. Fig. 2.

Suppoſe I would make an *Erect Direct South* Dial for the *Latitude* of 53 *Deg.* the Work in this is the very ſame as I have ſhewn in the *Horizontal Dial*; only here you muſt ſeek your *Latitude* in the *laſt* Column on the *right Hand,* or its *Complement* on the *left Hand*; and againſt either, for 11 and 1 a-clock, 9 *Deg.* 10 *Min.* for 10 and 2, 19 *Deg.* 9 *Min.* are to be ſet off from the *Meridian* by your *Line of Chords*; for 9 and 3 a-clock are 31 *Deg.* 2 *Min.* for 8 and 4 a-clock are 46 *Deg.* 12 *Min.* for 7 and 5 a-clock are 66 *Deg.* 10 *Min.* and for 6 a-clock are 90, and thus for any *Latitude* of *even Degrees,* an *Horizontal* and *South Direct* Dial may be expeditiouſly made by help of this *Table* and your *Line of Chords.*

What has been ſaid of the *South* Erect Dial is alſo applicable to the *North,* and therefore needs no Example.

TABLE V.

A TABLE of the *Three Requiſites* in *Dialing*, ſhewing the *Subſtile's Diſtance* from the *Meridian*, the *Stile's Height*, and the *Inclina-*

Declination.	Subſtile's Diſtance from the *Meridian.*		STILE's Height.		Inclination of *Meridians.*	
Degrees.	Degrees.	Minutes.	Deg.	Min	Degrees.	Minutes.
1	0	48	38	29	1	17
2	1	36	38	28	2	33
3	2	23	38	26	3	49
4	3	11	38	23	5	7
5	3	58	38	20	6	23
6	4	45	38	15	7	39
7	5	32	38	10	8	55
8	6	19	38	4	10	11
9	7	5	37	57	11	27
10	7	52	37	49	12	42
11	8	38	37	40	13	57
12	9	23	37	30	15	10
13	10	8	37	21	16	26
14	10	54	37	10	17	40
15	11	38	36	58	18	54
16	12	22	36	43	20	7
17	13	5	36	32	21	20
18	13	42	36	18	22	33
19	14	31	36	3	23	45
20	15	13	35	48	24	57
21	15	54	35	31	26	8
22	16	36	35	16	27	18
23	17	16	34	57	28	29
24	17	56	34	39	29	38
25	18	37	34	21	30	47

TABLE V.

tion of Meridians for the *Latitude* of *London*, anſwerable to the ſeveral *Degrees* of *Declination* of your *Plane*. N.B. How to find *theſe Requiſites* for any *other* Place, is ſhewn in Chap. XI.

Declination.	Subſtile's Diſtance from the *Meridian*.		STILE's Height.		Inclination of *Meridians*.	
Degrees.	Degrees.	Minutes.	Deg.	Min.	Degrees.	Minutes.
26	19	12	34	1	31	56
27	19	50	33	42	33	4
28	20	27	33	20	34	12
29	21	5	32	59	35	19
30	21	40	32	37	36	25
31	22	15	32	15	37	31
32	22	50	31	52	38	36
33	23	25	31	27	39	41
34	23	59	31	14	40	46
35	24	31	30	40	41	49
36	25	4	30	14	42	52
37	25	35	29	48	43	55
38	26	4	29	22	44	58
39	26	35	28	56	45	59
40	27	3	28	29	47	0
41	27	33	28	1	48	0
42	28	1	27	33	49	0
43	28	29	27	5	50	0
44	28	55	26	36	50	59
45	29	21	26	7	51	57
46	29	46	25	37	52	55
47	30	11	25	7	53	53
48	30	35	24	38	54	50
49	30	58	24	6	55	46
50	31	21	23	35	56	42

TABLE V.

A TABLE of the *Three Requiſites* in *Dialing*, ſhewing the *Subſtile's Diſtance* from the *Meridian*, the *Stile's Height*, and the *Inclina-*

Declination.	Subſtile's Diſtance from the *Meridian.*		STILE's Height.		Inclination of *Meridians.*	
Degrees.	Degrees.	Minutes.	Deg.	Min.	Degrees.	Minutes.
51	31	45	23	4	57	38
52	32	5	22	32	58	33
53	32	26	22	0	59	28
54	32	46	21	28	60	23
55	33	6	20	55	61	17
56	33	24	20	22	62	10
57	33	42	19	49	63	4
58	34	0	19	16	63	57
59	34	13	18	42	64	49
60	34	33	18	6	65	41
61	34	47	17	34	66	33
62	35	5	17	0	67	24
63	35	18	16	25	68	16
64	35	32	15	50	69	7
65	35	45	15	14	69	57
66	36	0	14	40	70	47
67	36	13	14	5	71	38
68	36	25	13	29	72	27
69	36	36	12	53	73	16
70	36	45	12	11	74	6

TABLE V.

tion of Meridians for the *Latitude* of *London*, anſwerable to the ſeveral *Degrees* of *Declination* of your *Plane*. N.B. How to find *theſe Requiſites* for any *other* Place, is ſhewn in Chap. XI.

Declination.	Subſtile's Diſtance from the *Meridian*.		STILE's Height.		Inclination of *Meridians*.	
Degrees.	Degrees.	Minutes.	Deg.	Min.	Degrees.	Minutes.
71	36	55	11	41	74	55
72	37	6	11	6	75	44
73	37	15	10	29	76	33
74	37	24	9	53	77	21
75	37	32	9	16	78	9
76	37	40	8	40	78	57
77	37	47	8	3	79	46
78	37	53	7	27	80	33
79	37	59	6	49	81	21
80	38	4	6	12	82	0
81	38	9	5	35	82	36
82	38	14	4	58	83	43
83	38	17	4	20	84	31
84	38	21	3	44	85	18
85	38	23	3	6	86	5
86	38	26	2	28	86	52
87	38	28	1	52	87	39
88	38	29	1	15	88	26
89	38	29	0	37	89	13
90	38	30	0	0	90	0

THE

EXPLANATION *and* USE

Of the foregoing

TABLE.

LASTLY, The Table of the *Three Requiſites in Dialling* is explained in Chap. XI. where I have ſhewn how to find the *Subſtile's Diſtance* from the *Meridian*, the *Stile's height*, and the *Inclination of Meridians* for *Latitude* 53 *Deg.* 22 *Min.* and the *Plane's Declination* 21 *Deg.* 10 *Min. Weſt*, which may ſerve as a *ſtanding Rule* for any other *Latitude* and *Declination* whatſoever.

TABLE VI.

A TABLE ſhewing the *Sun's Altitude* every *Hour and Quarter* of the *Day*, at his Entrance into the 12 *Signs* of the *Zodiack* for the *Latitude* of *London* 51 *Deg.* 32 *Min. North.*

N.B. This Table is uſeful in drawing *reflective Dials.*

Hours.	♋		♊	♌	♉	♍	♈	♎	♓	♏	♒	♐	♑	
	D	M.	D.	M.	D.	M.	D.	M	D.	M.	D.	M.	D.	M
XII	61	57	58	39	49	58	38	28	26	58	18	17	14	59
1	61	48	58	34	49	52	38	22	25	52	18	10	14	52
2	61	22	58	8	49	32	38	4	26	37	17	56	14	39
3	60	39	57	27	48	57	37	36	26	12	17	34	14	18
I XI	59	42	56	33	48	10	36	50	25	37	17	3	13	48
1	58	29	55	25	47	11	36	5	24	53	16	24	13	9
2	57	4	54	6	46	1	35	4	24	1	15	36	12	23
3	55	29	52	34	44	40	33	58	22	59	14	19	11	29
II X	53	45	50	55	43	11	32	36	21	49	13	36	10	28
1	51	53	49	7	41	52	31	8	20	31	12	24	9	19
2	49	54	47	12	39	37	29	34	19	6	11	6	8	3
3	47	51	45	13	37	57	27	53	17	36	9	42	6	41
III IX	45	42	43	7	35	59	26	5	15	57	8	11	5	13
1	43	31	40	58	33	57	22	12	14	13	6	34	3	39
2	41	15	38	45	31	49	22	25	12	23	4	51	1	59
3	38	59	36	30	29	40	20	13	10	30	3	5	0	15
IV VIII	36	40	34	14	27	28	18	7	8	32	1	13		
1	34	23	31	56	25	13	15	58	6	31				
2	32	4	29	37	22	56	13	46	4	25				
3	29	43	27	16	20	37	11	32	2	16				
V VII	27	23	24	50	18	18	9	17	0	5				
1	25	4	22	37	15	59	6	58						
2	22	46	20	17	13	39	4	39						
3	20	28	7	57	11	19	2	20						
VI VI	18	12	15	42	9	6								
1	15	58	14	0	6	44								
2	13	46	11	13	4	22								
3	11	37	9	1	2	8								
VII V	9	30	6	54										
1	7	27	4	46										
2	5	24	2	42										
3	3	27	0	43										
VIII IV	1	34												

THE EXPLANATION *and* USE

Of the foregoing

TABLE.

THIS Table ſhews the *Sun's Height* or *Altitude* at every *Hour and Quarter* of the Day, for the *Latitude* of *London*, and is uſeful in drawing *Hour Lines* upon your *Quadrant*,* and *alſo* for drawing the *Hour Lines* upon the Cieling of your Room in the *Reflective Dial*, and by your *Quadrant* you may find the *Sun's Altitude* at *any Time* of the Day, wherever you are, by holding your *Quadrant* up and looking through the *Sights* at the *Sun*, and the *Thread* will cut the *Limb* or *Arch* of the *Quadrant* in the *Degrees* of the *Sun's height* at that *Time* and *Place*; the *Minutes* muſt be *gueſſed at*, becauſe every *Degree* being ſuppoſed to be *divided* into 60 *equal Parts* called *Minutes*, and thoſe *Diviſions* called *Degrees* being *ſmall*, it is impoſſible they ſhould *actually* be divided into *Minutes* or 60 *equal Parts* ſo that if the *Thread* cuts a *Quarter* of a *Degree*, then call the *Minutes* 15, if it cuts *one Third* of a *Degree*, call them 20 *Minutes*, if a *half* 30, if *two Thirds* 40, if *three Fourths*, then the *Minutes* are 45, &c. and thus you may take the Height of the *Moon* and *Stars*. And by this means you may make the like Table for your *own* or any other *Latitude*.

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* For further Satisfaction herein you may ſee my *Syſtem of Aſtronomy*, Vol. I. Page 111.

CHAP. XX. *Shewing the* Uſe *of the* Scales *in* Plate II.

IN *Prob.* 9, 10, 11, and 12, I have ſhewn how to make the *Scales* in Plate II. and in *Chap.* XVI. *Page* 56, I have ſhewn *how to uſe* the Line of Chords, in meaſuring of any *right lined Angles*. The *Lines of Hours* and *Latitudes* are general for pricking down all Dials *with Centers,* as the *Horizontal, South Direct,* &c. as for

Example.

Let it be required to draw a Dial upon an *Horizontal Plane* for the *Latitude* of *London* 51 *Deg.* 32 *Min.*

See Plate 11. Fig. 1.

For the Hour Lines *and* Stile's height.

Draw CD for the *Meridian* or *Hour Line* of 12, and croſs it at *right Angles* in C, with AB; then from the *Scale of Latitudes,* ſet off CA and CB *each* equal to 51 *Deg.* 32 *Min.* for the *Stile's height*. Then take the *whole* Scale of Six Hours in your Compaſſes, and ſet it from A to D; draw AD and BD: *Divide* the Lines AD and BD as the *Scale of ſix Hours* is divided, and *thro'* thoſe *Diviſions* draw Lines to the *Center* C, which ſhall be the true *Hour Lines* ſought, to which put their *proper Figures* as you ſee done in the Dial.

This is a very ready and eaſy way to deſcribe the *Hour Lines* on any Plane.

For

For the Stile.

Take CA in your Compaſſes, and ſet from D to E, draw CE for the *Stile*, which muſt ſtand *perpendicular* upon the Line CD, and ſo is your Dial compleatly finiſhed.

Ever remember to make an Allowance for the *Thickneſs* of the *Stile* in all Dials, as I have cautioned you before.

An Example.

Of a *North* and *South* Erect Direct Dial for *Penzance* in *Cornwall*, whoſe *Latitude* is 50 *Deg.* 8 *Min.* N.

See Plate 11. Fig. 2.

This Dial is made the very ſame Way as I have juſt now ſhewn in the *Horizontal Dial*, only inſtead of taking the *Latitude* from the *Scale of Latitudes*, you muſt here in this Dial take the *Complement of the Latitude of the Place*, viz. 39 *Deg.* 52 *Min.* and ſet it from C to A, and B, which is alſo the *Stile's height*.

For the Hour Lines *of the* South *and* North *Dials.*

Take the *Scale of ſix Hours*, and ſet from A to D, draw AD and BD, then take in your Compaſſes *each* Hour *ſeverally* from the *Scale of ſix Hours*, and mark them off in the Lines AD and BD; *thro' thoſe Points* draw Lines from the *Center* C, and they ſhall be the *true Hour Lines* required.

For the Stile.

Set A C from D to E, and continue it *beyond the Center* C, which ſhall be the *Stiles* for the *North* and *South* Dial, as you ſee done in the Dials.

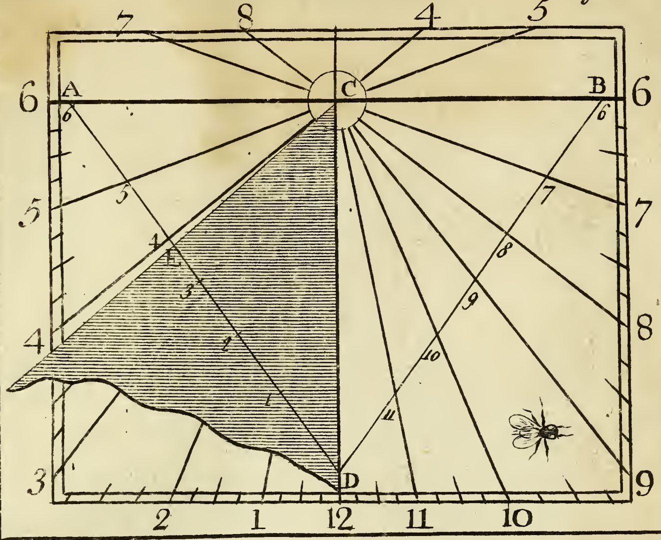
By

Theſe Dials are made by ye Scales in Plate 2

Plate II

A Horizontal Dial

Fig I



7
8
4
5
6
A
C
B
6
6
6
5
5
7
7
4
E
3
8
8
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2
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1
11
3
D
9
2
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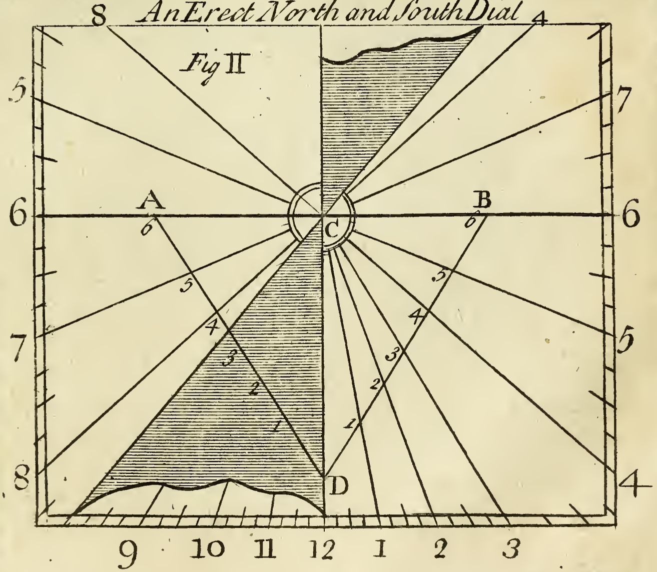
12
11
10

An Erect North and South Dial

Fig II



8
4
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6
A
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C
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4
5
3
3
2
2
1
1
8
D
4
9
10
11
12
1
2
3

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By the *Scale of Inclinations* is known in *erect Decliners* where the *ſubſtilar Line* will fall; which muſt always be on the *contrary Side* the *Meridian Line* or *Hour Line* of 12; that is, if the Plane declines *Weſtward* the *ſubſtilar Line* muſt ſtand on the *Eaſt-ſide*, but if the Plane declines *Eaſtward*, then the *ſubſtilar Line* muſt be placed on the *Weſt-ſide* the *Meridian:* and if the *Inclination of Meridians* be *leſs* than 15 *Deg.* the *ſubſtilar Line* will fall *between* 11 and 12, or between 12 and 1 a-clock, according to which *Point of the Heavens* the Plane *declines:* if the *Inclination of Meridians* be more than 15 *Deg.* but leſs than 30, the *ſubſtilar Line* will fall between the Hours of *one* and *two*, &c. *Some Dialiſts* put the *Difference of Meridians* of *ſeveral Places*, as *Jeruſalem*, *Madrid*, *&c.* upon the Dial, to ſhew the Time of the Day at *thoſe* Places, as well as the Time *where you are*; but this is needleſs; for if at any Time you would know what a-clock it is at any Place in the known World, when it is ſuch a Time at *London*, only turn to the Table of the *Latitude and Longitude* of Places at the End of this Treatiſe, and there ſee what the *Difference of Meridians* is; and if the Place be to the *Eaſt* of *London*, add the *Difference of Meridians in Time* to the Time at *London*, which gives the Time at *that* Place; but if it lie to the *Weſt*, ſubſtracting the *Difference of Meridians* in Time from the Time at *London*, gives you the Time of the Day at *that* Place.

Example.

Suppoſe it is 10 a-clock in the *Forenoon* at *London*, what Time is it *then* at *Conſtantinople*, and alſo at *Port Royal* in *Jamaica?*

Given

	H.	*M.*
Given Time at *London* is	10	00
Conſtantinople to the *Eaſt* (add)	1	59
Time at *Conſtantinople*	11	59

That is 59 Min. *paſt* Eleven in the *Forenoon.*

Again.

	H.	*M.*
Given Time at *London* is	10	00
Port Royal to the *Weſt* (ſubſtract)	5	4
Time at *Port Royal* in the *Morning*	4	56

The like of any other Place in the *Catalogue.*

The Uſe *of the* TRIGON.

See the Figure on Page 10.

You are to take notice, that the *Parallels of the Signs,* the *daily Arches,* the *Circles of Altitude,* and *all other Circles* relating to the *Courſe of the Sun,* when they are deſcribed upon any *Sun Dial,* are not ſhadowed out by the *whole Stile,* or *Axis of the Dial* as the *Hours* are, but by ſome *one Point* in the ſame *Stile* or *Axis*; as by a *Knob, Button* or *Notch,* filed in the *Stile* of the Dial, or by a *Hole in a Glaſs Window* for *projected Dials,* or by a *Piece of Looking-Glaſs* for *reflected Dials*; in all which Caſes the *Trigon* at C is to be applied, ſo that the Line thereof marked AB, muſt lie upon the *Stile* of the Dial, or *parallel* to the Axis of the World, if it be an *Hole in a Window,* or a *Piece of Looking-Glaſs:* And now, the *Trigon* being thus placed with the *Equinoctial* CD ♈ *perpendicular to the Stile,* the *Center* being always fixed upon the *Button* or *Notch,* or *Knob,* ſo that you may turn it about the *Axis,* as occaſion ſhall require.

For

For the Equinoctial.

Now ſuppoſe you would inſert the *Equinoctial* into any Dial, (for *one Rule ſerves for all Planes.*) *Firſt,* put a *Thread* through the *little Hole* marked with ☉ at ♈ and ♎, tying a Knot on the Thread that it ſlips not through the *Hole* in the *Trigon;* then put the *Center* C to the *Knob* in the *Stile,* and the *Side* AB to *the Stile itſelf:* This done, extend the *Thread* over the Line CD ♈ till it touches the Dial Plane: that Point *of touching* ſhall be *one* Point through which the *Equinoctial* is to be drawn upon the Plane: Then turning the *Trigon about,* ſtill keeping the Line AB *parallel to the Stile,* extend the *Thread* till it touch the Dial Plane in ſome *other Point,* and that ſhall be *another Point,* through which the *Equinoctial* is to be drawn upon the Dial.

And if your Dial be all but *one plain Superficies, two Points* will be ſufficient to draw the *Equinoctial* by, it being a *great Circle* of the *Sphere,* and conſequently a *right Line* upon all *plain Superficies,* But,

If the Dial conſiſt of *more than one* Plane, then muſt you, in the ſame manner as *before,* find *two Points at leaſt* upon *each Superficies;* which you may eaſily and ſpeedily do by turning the *Trigon* about the *Stile,* and keeping the Side AB *parallel* thereto, extending the *Thread* over the Line CD ♈ till it touch the Plane.

For the Tropick of Cancer.

In like manner if you would inſert the *Tropick of Cancer* into your Dial, you muſt put the Thread in *the Hole* at ♋, and then apply the *Center* C to the

Knob in the *Stile*, keeping the Side AB *parallel to the Stile* (as before) extend the Thread over the Line C♋ till it touch the Plane, and that Point of touch muſt be *one Point* through which the *Tropick* of *Cancer* muſt paſs.

Again move the *Trigon* in the *ſame Poſition* upon the *Stile of the Dial* as occaſion requires; extend the Thread over the *Tropick* C♋ till it touch the Plane, and that ſhall be *another Point* through which the *Tropick* muſt be drawn, and in this manner you may find as many Points upon the Plane as you pleaſe, and *the more the better*, for *theſe Parallels* will not be *ſtreight Lines*, as the *Equinoctial Line* was, but *conic* or *curved Lines*, *through* which Points a Line *being traced*, with an *even hand*, ſhall be the *Tropick of Cancer* upon your Dial Plane.

For the Tropick of Capricorn.

And in this manner may the *Tropick of Capricorn*, and all the *Parallels* of the *other Signs* (or any other *Parallel* of the *Sun's Declination*) be drawn on your Dials, if firſt you put the *Thread* through the *reſpective Hole*, and apply the *Trigon* to the *Stile*, and extend the Thread over the *Parallel of Declination* till it touch the Plane; *and thus* you may find as many Points as you pleaſe, thro' which to draw your *Parallels*; and this may ſuffice for the Inſcription of the *Parallels* of the *Signs of the Zodiack*.

And if you would inſert the *Parallels* for the *length of the Day*, they are to be done in the ſame manner, if inſtead of the *Declinations for the Signs*, you put into your *Trigon* the *Parallels* for the *length of the Days* you intend to inſert into your Dial.

N. B. In Page 90 I have given a caution to all *Dialiſts*, that they be careful *always to make Allowance* for the *Thickneſs* of the Stile, otherwiſe the *Dial* will err from the Truth.

CHAP. XXI. *A Review of the* Equinoctial *and* Direct Eaſt *and* Weſt *Dials.*

Of the Equinoctial *Dial, after what it ſaid concerning it in* CHAP. III.

IF to this you add a *Semicircle* to repreſent *one half* of the *Meridian*, and graduate the *Meridian* unto 180 Deg. by two Ninety's, and ſet it in a Notch over a Box and Needle well touched with a Loadſtone, it will ſhew you the Hour of the Day whereever you be, as alſo the *Variation* of the Needle itſelf in that Place; for when you have ſet it to ſhew the *Hour*, if the *Needle* then lies *parallel* with the Semicircle, repreſenting *one half* of the *Meridian*, it has then no Variation, but if it lies athwart with the *Meridian*, the *Angle* that it makes either to the *Eaſt* or *Weſt* is the *Variation* of the Needle in that Place.

N.B. It matters not whether you put any more *Hour Lines* upon the Dial than are *uſeful in the Latitude where you are*; as for inſtance, at *London* you may omit the Hours *after eight at* Night *till four in the* Morning.

How naturally the *Hour Lines* may be drawn upon any Plane from the *Equinoctial Dial*, I ſhall here ſhew. Fix your *Stile* to your Dial Plane *in its right Poſition* by help of your *Quadrant*, *i. e.* by applying the Edge thereof to the Stile, and then the String cutting the Limb thereof in the Degrees of the *Latitude* of your Plane, becauſe the *Top* of the Stile is *parallel* to the *Earth's Axis*; and be careful alſo that it ſtands at *right Angles* to the + *ſubſtilar Line*, whatever Dial it be; then cut a Slit quite thro' the *Equinoctial Dial* from the *North Edge* to the *Center* along the 12 *a-clock Line*, juſt ſo wide as to receive your Stile; put this Slit upon the Stile of your Dial, ſo that the *Equinoctial Dial* may ſtand at *right Angles* thereto, for then doth it lie parallel to the Plane of the *Equinoctial* itſelf: From that Point where the *Equinoctial Dial* toucheth the Stile, let fall a Perpendicular upon the *ſubſtilar Line*, this I call the *perpendicular height* of the Stile; take this in your Compaſſes, and ſet one foot in the *ſubſtilar Line* where the *perpendicular height* of the Stile touched it, and ſweep a *Circle*; to this Circle draw a *tangent Line* at *right Angles* to the *ſubſtilar Line*; *Laſtly*, Put a Thread in the *Center* of the *Equinoctial Dial* (allowing for the Thickneſs of the Stile) and ſtretch it over the *Hour Lines*, and where the Thread toucheth the *Tangent Line* upon your Plane make Marks; and Lines drawn from the Center of your Dial to thoſe Marks in the *Tangent Line* are the true *Hour Lines* upon your Dial: and this is a plain and ready way of drawing *Hour Lines* upon all Sorts of Planes.

A Review *of the direct* Weſt *Dial.*

After what is ſaid concerning it in Chap. VII. VIII.

This Dial as well as the *Eaſt* Dial is univerſal, which I thus explain; procure a Plate of Braſs of what Size you pleaſe, and about the Thickneſs of a Shilling, well poliſhed on both Sides, on which draw an *Eaſt Dial* on *one* Side and a *Weſt Dial on the other*, ſo that the Center of the Circle PHDS, on *one* Side may exactly anſwer the Center of the Circle on the *other* Side; let a Circle circumſcribe your *Dials*, and the upper Quadrant divided into 90 equal Parts or *Degrees*; let there be a Ring in a ſwivel to ſcrew to the *Zenith* of the Place wherever you be, after the manner of a *Ring Dial*; then hanging it on your Finger, placing its Plane parallel to the Meridian of the

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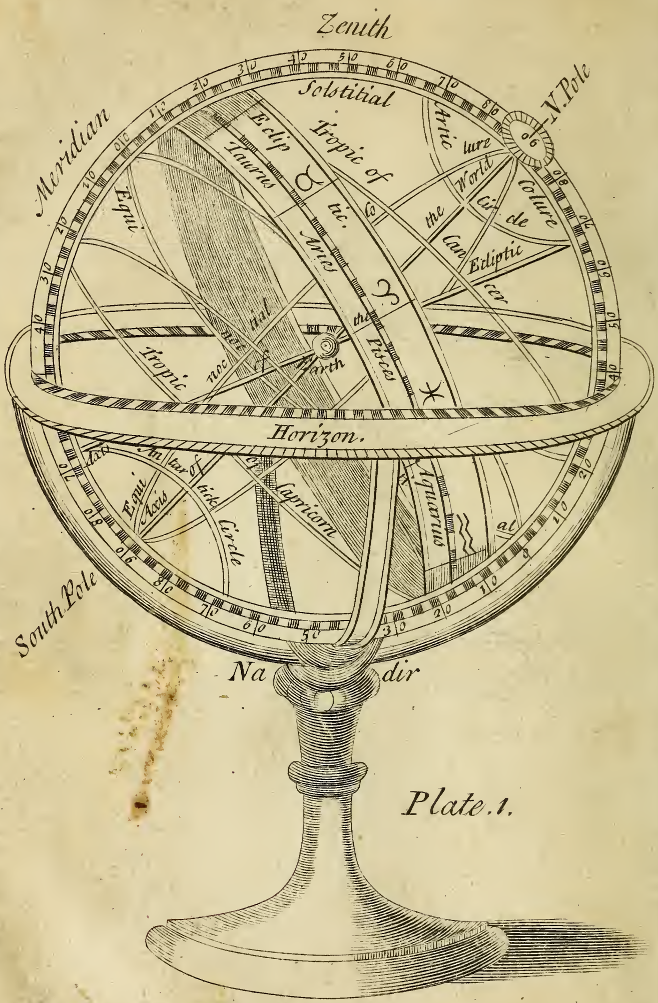
Zenith
Meridian
Solstitial
Tropic of
Artic
lure
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Earth
Pisces
Horizon.
Axis
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60
70
80
90

Plate. 1.

The Sphere

the Place (which may be done by help of a Magnetic Needle) it will ſhew you the true Hour of the Day, except it be exactly 12 a-clock, and then neither the *Eaſt* or *Weſt* Side will ſhew the Hour, for the Shadow of the Stiles do then fall off both the Planes.

Theſe Things I mention as Curioſities, ſhewing how by keeping the Axis of your Dial parallel with the Axis of the World, the Dial by that means is univerſal, for under the *Arctic Pole* the Hour-line will be *perpendicular* to the Horizon, and under the *Equinoctial* they will become *parallel*, or lie in the Plane of that great Circle. But if under the *Equinoctial* you lay the Dial flat down, ſo that the Circle PHDS may repreſent the Horizon of that Place, and placing 12 where 6 now ſtands, one where 5 is, *&c.* and 11 where 7 is, and 10 inſtead of 8, *&c.* to 6; this Dial will then repreſent a *Polar* or *Equinoctial* Dial, which ever you pleaſe to call it.

CHAP. XXII. *A* DESCRIPTION *of the* SPHERE. (*See the* Print.)

THERE are *Ten* eminent *Circles* upon the Sphere; *Six* of which are called *greater Circles*, and the other *Four* are called *leſſer Circles.*

A *great Circle* of the *Sphere* is that whoſe *Plane* paſſeth through the *Center* of the Sphere, and divides the Sphere itſelf into *two equal* Parts.

A *leſſer Circle* is that which lies *parallel* to a *greater*, as the *Tropicks* or *Polar Circles* do to the *Equinoctial.*

Or *leſſer Circles* are ſuch as do *not* divide the Sphere into *two equal* Parts.

The ſix *greater* Circles are the *Horizon*, the *Meridian*, the *Equinoctial*, the *Ecliptick*, the *Equinoctial Colure*, and the *Solſtitial Colure*, and the four *leſſer Circles* are the *Tropick* of *Cancer*, the *Tropick* of *Capricorn*, and the *two Polar Circles*. But,

Firſt, *Of the* Six *great Circles.*

1. The *Horizon* is that *Circle* whereon the *Earth* and *Sky* ſeem to meet, and therefore when the *Sun*, *Moon*, and *Stars* come to the *Eaſt* thereof they are ſaid to *riſe*, and when they come to the *Weſt* thereof they are ſaid to *ſet*.

2. The *Meridian* is that *Circle* which is exactly in *the Middle* between the *Eaſt* and *Weſt*, and always cuts the true *North* and *South* Points of the *Horizon*; its *Uſe* is to ſhew the Time of *Mid-day* and *Midnight*; for when the *Sun* comes to the *South Point* of *this* Circle which is *above* the *Horizon*, it is *Noon*; and when to that Point of the Circle which is *under* the *Horizon*, then it is *Midnight*; and *that Point* in the *Meridian* which is exactly *over your Head*, is called the *Zenith*; and that *under your Feet* the *Nadir*.

3. The *Equinoctial* Circle is always diſtant from you as much as is *the Latitude of the Place* you are in, and is alſo *equal* to the *Height of the Pole* above your *Horizon*; its *Uſe* is to determine the Time of the *Day* or *Night*; for every 15 Deg. thereof is *equal* to *one Hour in Time*, and it always cuts the true *Eaſt* and *Weſt* Points of the *Horizon*.

4. The *Ecliptick* is that Circle in which the *Sun* is ſaid to move, and *this Circle* cuts the *Equinoctial* in the *beginning* of *Aries* and *Libra*, making an *Angle* therewith of 23 Deg. 29 Min. which *Angle* is equal to the *Sun's greateſt Declination*: It is divided into

twelve equal Parts, called *Signs*, and *charactered* as in the *Figure* with ♈, ♉, ♊, *&c.* and every *Sign* is divided into *thirty* equal Parts called *Degrees*; ſo that *This*, and *every great Circle* of the *Sphere* contains 360 *Degrees.*

N. B. In or *near* this *Circle* the *Eclipſe* of the *Sun* and *Moon* are always found, from whence it takes its Name.

5. The *Equinoctial Colure* is a Circle that cuts the *Equinoctial* at *right Angles* in the *beginning* of *Aries* and *Libra*, and paſſes *thro'* the *Poles* of the World: This Circle determines the *beginning* of the *Spring*, and *fall of the Leaf*; for when the *Sun* comes here (which is on the 21ſt of *March*, and 22d of *September*) the *Days* and *Nights* are equal.

6. The *Solſtitial Colure* is a Circle that cuts the *Equinoctial Colure* at *right Angles* in the *Poles* of the World, and when *Cancer* is upon the *Meridian*, *this* Circle is alſo upon the *Meridian* (as you may ſee by the Sphere) when the *Sun* comes to this *Colure* (which is upon the 21ſt of *June*, and the 22d of *December*) he determines the *longeſt* and *ſhorteſt Days* to all the Inhabitants on the *North Side* the Equinoctial.

N. B. The above *ſix Circles* cut the *World* into *two* equal Parts.

Secondly, *Of the* FOUR leſſer Circles *of the Sphere.*

1. The *Tropick of Cancer* is parallel to the *Equinoctial*, and diſtant from it 23 Deg. 29 Min. which is the *Sun's greateſt Declination Northward*; here the *Ecliptick* and the *Solſtitial Colure* meet in the very beginning of *Cancer*, making the *longeſt Day* to all the *Northern* Inhabitants.

2. The *Tropick of Capricorn* is alſo parallel to the *Equinoctial*, but diſtant from it 23 Deg. 29 Min. towards the *South*, and is equal to the *Sun's greateſt Declination*; here the *Ecliptick* and *Solſtitial Colure* meet in the very beginning of the Sign *Capricorn*, making the *ſhorteſt Day* to all the *Northern* Inhabitants.

The Reaſon why theſe are called *leſſer* Circles is, becauſe they cut the *Sphere* (or World) into *two unequal* Parts.

Lastly, The *two Polar Circles* are the ſame Diſtance from the *Poles*, that the *Tropicks are* from the *Equinoctial*, viz. 23 Deg. 29 Min. When the Sun enters *Cancer*, thoſe that live under the *Arctic Circle* ſee him in their *Horizon* at *Midnight*, and when the *Sun* enters *Capricorn*, thoſe that live under the *Antarctic Circle* ſee the Sun in their *Horizon* at *Midnight*.

The *Earth's Axis* is a Line ſuppoſed to paſs from *Pole to Pole*, and *through* the *Earth's Center*; and *note*, it always repreſents the *Top*, or uppermoſt Part of the *Stile* in *all Dials*: and makes an *Angle* with the *Horizon* equal to the *Latitude* of your Habitation: and it always cuts the *Equinoctial* at *right Angles*, and the *Equinoctial* makes an *Angle* with the *Horizon* equal to the *Complement of the Latitude of the Place* where you live.

The *Earth* is fixed upon its *Axis* in the *middle* of the Sphere (or World) and in *Dialling* it is reckoned no more than a *Point*, becauſe it is at ſo vaſt a Diſtance ftom the *Sun*.

N. B. The *Axis* of the *Ecliptick* is noted in the *Sphere*, but is of no manner of Uſe in Dialling.

CHAP.

CHAP. XXIII. Latin Mottos *for Dials, with their Meaning in* Engliſh.

1 *ALIIS inſerviendo conſumor.*
Profit by my Loſs.
2 *Ars longa Vita brevis.* Art is without End, Life but a Span.
3 *Avaritia hodie dominatur.*
You covet to-morrow.
4 *Aut Cæſar aut nihil.* I ſhine or ſhroud.
5 *About your Buſineſs.
6 *Amat Lucem.* It loves the Light.
7 *Adveniet ille Dies.* The Day will come.
8 *Abi, non moratur Hora, ambula in Luce.*
Begone, the Hour flies, walk in Light.
9 *Alias et idem.* Every where the ſame.
10 *Aſpice fugimus.* Behold we fly.
A [or *e*] *Cælo Veritas.*
11 Truth the Daughter of Heaven.
12 *Agi ad pœnitendum.* Forced to recant.
13 *Bulla eſt vita humana.* Life's a Bubble.
14 *Brevis Hominum vita.* Short is human Life.
15 Behold and be gone about your Buſineſs.
16 Conſume not thy Time in Idleneſs.
17 *Curſum peregi.* I have finiſhed my Courſe.
18 *Circumſpicit omnia.* He beholds all Things.
19 *Claritatem et ſplendorem ſolis indico.*
I ſhew by the Kindneſs and Splendor of the Sun.
20 *Cum tempus non exiſtit, tunc morior.*
When Time ceaſes to exiſt, I ſhall be forgotten.

---

* On the *General Poſt-Office.*

21 *Certitudinem acquirit eundo.*
Its Progreſs confirms its Certainty.

22 *Carpe diem.* This is the Day.

23 *Carpe diem quam minimum credula poſtero.*
None can tell what will happen to-morrow.

24 *Cui ſolem ante ferum?*
What can be compared with the Sun?

25 *Cito pede labitur ætas.* Time paſſes ſwiftly away.

26 *Cito pede præterit ætas.* Time ſwiftly flies away.

27 *Concito gradu.* My Flight is rapid.

28 *Conſidera te.* Know thyſelf.

29 *Certa Ratio.* An account muſt be given.

30 *Cædimur merito.* We ſuffer deſervedly.

31 *Deus adeſt laborantibus.*
Heaven favours the Diligent.

32 *Diſce dies numerare tuos.*
Learn to value your Time.

33 *Diſce bene vivere & mori.*
Live and die hapy.

34 *Dies diem trudit.* A Day may ruin thee.

35 *Dum ſpectas fugio.* I fly while you behold me.

36 *Dona præſentis cape lætus.*
Enjoy the preſent Hour.

37 *Diſcite juſtitiam moniti.**
Learn to be wiſe in Time.

38 *Dum ſpectas fugit hora.*
The Hour flies while you are gazing.

39 *Dum fugio numeras.* I fly while you number.

40 *Diſce mori mundo.* Die to the World.

41 *Dum fugit umbra, quieſco.*
The Shadow moves tho' I am at Reſt.

42 *Durabat ſplendor ſolis.*
The Light of the Sun ſhall endure.

---

* At *Weſtminſter-Hall.*

43 *Dona præſentis rape lætus.*
Chearfully accept of Things preſent.

44 *Depreſſa reſurgo.* I ſet to riſe.

45 *Dare quam accipere.*
It is more bleſſed to give than to receive.

46 *Dum videam ſatis eſt.*
If I but ſee it is ſufficient.

47 *Dum ſpectas ſplendit.*
Whilſt thou art looking he ſhines.

48 *Diſponit tempus dies.* Days make Years.

49 *Dies affert multa.*
Sufficient to the Day is the Evil thereof.

50 *Diſce tuos numerare dies.*
Learn to number thy Days.

51 **En ſupra vita fugax.*
†*En infra certa mors.*
A Life on Flight's ſoon out of Sight.

52 *Ex hoc momento pendet æternitas.*
On the preſent Moment depends Eternity.

53 *Eheu fugaces labuntur anni!*
Where is laſt Year flown!

54 *Ecce ut hora ſic fugit vita.*
Life flies like the Hour.

55 *Ecce hora.* Now or never.

56 *Et nobis et vobis.* To us and you.

57 *Eternam tibi ſemper adeſſe puta.*
You are on the Brink of Eternity.

58 *Ecce nunc tempus acceptabile feſtinè ſalvare.*
Now is the accepted Time, now is the Day of Salvation.

59 ***Edwardus fovet ut ſol.*
Edward beneficent as the Sun.

---

* At the *Top*
† At the *Bottom* of *one* Face of a Dial on *St. Mary Overy's* Church, *Southwark,* which hangs over the Burial-Ground.

** On *Chriſt's* Hoſpital, founded by EDWARD the VIth.

60 *Extricas nihil.* Effect nothing.

61 *Exhibe fidem vocis.* Perform your Promiſe.

62 *Feſtina lente.* Obſerve my Motion.
Do nothing haſtily.

63 *Fortuna urbes ampliſſimas evertit.*
No Exemption from my Influence.

64 *Fugio fuge.*
Be gone about your Buſineſs.
I ſtay for no Man.

65 *Feſtinat ſuprema.* The laſt Hour approaches.

66 *Fugit dies (vel hora)* The Day flies.

67 *Fugit ætas avara.*

68 *Fugit hora ſine mora.*
Time paſſes away without Delay.

69 *Fruſtra me extinguis.* To ſtop me is impoſſible.

70 *Finem vitæ ſpecta.* Such is Life.

71 *Fumus et umbra ſumus.***
Smoke and Shadow are Emblems of Life.

72 *Fugax eſt ætas.*
Life is of ſhort Continuance.

73 *Fugit irreparabile tempus.*
Time when paſt is irreparable.

74 *Grata ſuperveniet hora.*
May it be a welcome Hour.

75 *Grata ſuperveniet.* May it be welcome.

76 *Grata ſuperveniet quæ non ſperabitur.*
The leſs expected the more pleaſing.

77 **Hinc vivere diſce.* Riſing portends ſetting.
†*Illinc diſce mori.*

78 *Hora quaſi umbra.* Man is but a Shadow.

79 *Homo fugit rapide lethumq; invadit inermes.*
The Hours glide ſwiftly, and the ungarded are eaſily ſurpriſed.

** On a Dial on a *Chimney.*

* At the *Top* of *another* Face of the Dial on *St. Mary Overy's* Church, *Southwark,* which hangs over the Burial Ground.
† At the *Bottom*

80 *Hora pars vitæ.* Every Hour ſhortens life.
81 *Horam quam petis redimite.*
Redeem the Time.
82 *Haud mora carpe diem.*
Seize the preſent Opportunity.
83 *Hoc tuum eſt.* The preſent only is thine.
84 *Heu! quærimus umbram.* We purſue ſhadows.
85 *Horam vitam imminuit.* Every Hour ſhortens life.
86 *Hoc age.* Remember.
87 *Hodie mihi cras tibi.* Each in his Turn.
88 *Ita vita.* Such is life.
89 I bide my Time. I ſtay for no Man.
90 *Immotum in motu.* Ever the ſame.
91 *Inter Cæſarem & Galbam*
Sol miniſtrat umbram.
The Sun is alike beneficent to all.
92 *Interpres fidus ſolis.*
I interpret faithfully the Sun.
93 *Indico utere.* Improve by my Admonition.
94 *In ſingulas horas.* Every Moment.
95 *Ingravantibus annis.* Our Years multiply.
96 *Labor ipſe voluptas.* I labour for your Pleaſure.
97 *Lex Dei lux Diei.*
The Law of God is as clear as the Light.
98 Let your Light ſo ſhine that Men may ſee your good Works.
99 *Lente ſuſcipe cito perfice.*
Set out at Leiſure, proceed with Haſte.
100 *Luce laborandum.* Walk whilſt it is light.
101 *Luce lucit.* He ſhines in the Light.
102 *Lux poſt umbram.* After Darkneſs Light.
103 *Lux venit ab alto.* Light comes from above.
104 *Leges luce clariores.*
Thy Commandments enlighten the Eyes.
[104] *Luceo et lateo.* I ſhine and ſet.

105 *Lux umbra Dei* God is Light.
Light is God's Shadow.
106 Look forward.
107 *Ludimus leve.* We trifle.
108 *Lues culpam ſpiritu.* Your Life ſhall pay for it.
109 *Mora trahit periculum.*
Delay is the Parent of Danger.
110 *Me ortum vides forſan non occaſum.*
You have ſeen me riſe, but may not ſee me ſet.
111 *Maneo nemini.* I ſtay for no Man.
112 *Memor eſto brevis ævi.*
Remember the Shortneſs of Life.
113 Mind your Buſineſs.
114 *Monſtrat in ſilentio.* Silent Inſtruction.
115 *Mors ultima pœna eſt.* Death cloſes the Scene.
116 *Mors omnia vincit.* Death conquers all.
117 *Mors de die accelerat.*
Every Day brings Death nearer.
118 *Mors nobis quotidie imminet.*
This Day may be your laſt.
119 *Memor eſto quod morieris?*
Can you forget you are mortal?
120 *Mors meta laborum.* Death terminates Labour.
121 *Mors iter ad vitam.* To die is to live.
122 *Moriendo vivo.* I live and die daily.
123 *Metam properamus ad unam.* All muſt die.
124 *Mortalia cogita.* Remember thou art mortal.
125 *Me lumen vos umbra regit.*
Light directs me, and you a Shadow.
126 *Mors omnia ſternit.* Death conquers all.
127 *Me nutrit Apollo.* *Apollo* is my Teacher.
128 **Mentiri non eſt meum.*
Lying does not belong to me.

---

* On a Dial facing *Billingſgate*, where the Dealers in Coals aſſemble daily.

129 Man's but a Shadow.
130 *Nemo ſine crimine vivit.*
The brighteſt Day has its Shades.
131 *Nil dat quod non habet.*
Of nothing, nothing can be produced.
132 *Non ſemper erunt Saturnalia.*
Take Time by the Forelock.
133 *Non nobis nati ſumus.*
We are not made for ourſelves.
134 *Non ſine lumine.* Not without Light.
135 *Noſce teipſum.* Know thyſelf.
136 *Nulla dies ſine linea.* Improve every Day.
137 *Noli confidere noctem.*
You are not ſure of ſeeing Night. Certain
138 *Non progredi et regredi.*
Every Stop leſſens the Progreſs.
139 *Nos flendo ducimus horas.*
Life is a melancholy Tale.
140 *Naſcimur & morimur.* Born and dead.
141 *Non moror.* I never ſtop.
142 *Non redibo.* Never to return.
143 *Nec ſol in ſummo manet.*
The Sun has his Viciſſitudes.
144 *Nil boni hodie diem perdidi.*
What good Actions have you performed to-day?
145 *Nec metuendo viris.* Indifferent to the Wiſe.
146 *Neque lux ſine umbra.*
No Light without a Shadow.
147 *Nocet umbra nocenti.*
148 *Non ſemper clarum.* Not always intelligible.
149 *Nos ut umbra.* We reſemble the Shadow.
150 *Neſcitis horam.* Ye know not the Hour.
151 *Non vetuit mori.* No flying from Death.
152 *Noſtra latet.* We know not our End.

153 *Non memet extinguo.*
My Term is not my own Decree.

154 *Non quantum, ſed quo modo.*
The Manner, not the Matter.

155 *Non aliter perio ſpecies quam futilis umbræ.*
My Emblem is a Shadow.

156 *Nihil velocius annis.* Nothing fleeter than Time.

157 *Non in tenebris.* Not in Darkneſs.

158 *Non rego niſi regar.* As I am directed I direct.

159 *Noli imputare mihi.*
Place them not to my Account.

160 *Nocendum nulli.* Injure no Man.

161 *Noli iraſcaris.* Avoid Anger.

162 *Omnem crede diem tibi diluxiſſe ſupremum.*
Believe every Day to be the laſt.

163 *Omnia falce metit tempus.*
Nothing can reſiſt the Scythe of Time.

164 *Orimur et morimur.* We riſe and ſet.

165 *Ombra fallace que mentres appreſſa fuge!*
Deluſive Shadow, ſo ſpeedy in thy Flight!

166 *Otium fuge.* Fly Idleneſs.

167 *Omnia fert ætas.*
Time brings all Things to paſs.

168 **Oriens ſol adornatur.*
When Sol adorns the Eaſt.
All worſhip the riſing Sun.

169 *Pereunt et imputantur.*
The Hours vaniſh, yet are recorded.

170 *Pax optima rerum.* Light is the Parent of Peace.

171 *Poſt voluptatem miſericordia.*
†Pleaſure is the Parent of Pain.
Night treads upon the Heels of Day.

---

* An *Eaſt* Dial.

† Upon a Dial at a *Lock*, or Hoſpital for thoſe who have the *foul Diſeaſe.*

172 Peace, Love and Unity, thro' Time to Eternity.

173 Prize Time.

174 *Pulvis et umbra ſumus.*
Life paſſes like the Shadow.

175 *Proba veritatem mei.* Try me.

176 *Publica privatis ſecernite ſacra prophanis.*
Be always diſcreet.

177 *Plura labori dulcibus quædam otiis.*
Repoſe after Labour is ſweet.

178 *Poſt tenebras lucem.* After Darkneſs Light.

179 *Poſt tenebras ſpero lucem.*
After Darkneſs I hope for Light.

180 *Præſtant æterna caducis.*
Eternity alone merits our Attention.

181 *Procraſtinatio eſt odioſa.*
Delays are dangerous.

182 *Poſt eſt occaſio calva.*
Do not omit the preſent Opportunity.

183 *Phœbus inſtar reviviſco.*
I revive like the Sun.

184 *Phœbus recreat quæ vulcanus excuſſit.*

185 *Proxima non noſtra eſt.*
The next is not in our Power.

186 *Qualis vita, finis ita.*
A virtuous Life, a happy Eternity.

187 *Quod tibi fieri non vis, alteri ne feceris.*
Do as you would willingly be done by.

188 *Qua redit neſcitis horam.*
Ye know not the Hour.

189 *Quid celerius tempore?*
What is ſwifter than Time?

190 *Quam quæras ne perdas.*
Secure it whilſt in your Power.

191 *Quid cunctaris niſi occupas fugit.*
Seize the flying Hour.
192 *Quod petis umbra eſt.*
You purſue a Shadow.
193 *Quod vides non diu.*
The Things ſeen are temporal.
194 *Qua pota lucit.* Exert your Talents.
195 *Quid optas quod habes.*
Ridiculous ! to wiſh and have.
196 *Quaſi umbra tranſit vita.*
Life paſſes like the Shadow.
197 **Quid ſtans ? tranſit eſt hora.*
All is temporary, and paſſeth like the Hour.
198 *Quid multa ?* One Thing is neceſſary.
199 *Quanta res !* How important !
200 *Redime tempus.* Redeem the Time.
201 *Redime tempus, nil perpetuum.*
Redeem the Time, it will ſoon be gone.
202 *Redime tempus, vivitur ex rapto.*
Redeem the Time, the Tenure is uncertain.
203 *Revocabile tempus.* Recall the Time.
204 *Reſurga.* Awake to Life.
205 †*Reſurgam.* I ſhall riſe again.
206 *Ruit hora.* The Hour flies.
207 Remember.
208 *Rus in urbe.* The Country in the City.
209 *Religionem cole.* Honour Religion.
210 *Sic vita.* Such is Life.
211 *Sic tranſit gloria mundi.*
So marches the God of Day.
212 *Sine lumine inane.* Not without Light.
213 *Sic præterit ætas.* Life flies ſwiftly.

---

* On the Church Porch of *Calbeck* in *Cumberland.*

† Alluding to the ſetting Sun.

214 *Sic hominis vita.* Such is the Life of Man.
215 *Semper in motu.* Ever in Motion.
216 **Sol lucet charitas extendit omnibus.*
Charity, like the Sun, is beneficent to all.
217 So flies Life away.
218 *Senſim ſine ſenſu.* Inſenſibly.
I move inſenſibly.
219 *Seneſcimus effugit ætas.* Old Age approacheth.
220 *Semper paratum.* Be always prepared.
221 *Subſerviens vehicula lucis.*
222 *Sic tibi tempus erit.*
Your Time is approaching.
223 *Suprema hæc multis forſan tibi.*
The laſt to many, poſſibly to you.
224 *Suprema multis hora forſan tibi.*
The laſt Hour to many, poſſibly to you.
225 †*Sicut flos.* Like a Flower.
226 *Sol miniſtrat umbram.*
The Sun cauſes the Shadow.
227 ‖*Sumus fumus.* We vaniſh like Smoke.
228 So flies Life away.
229 *Sol gloria ſpheræ.*
The Sun gives a Luſtre to the Univerſe.
230 *Sic ſiti lætantur lares!*
How delightful the extended Proſpect!
231 *Sic imus ad atria lucis,*
Aut umbras erebi.
Thus we paſs on to Happineſs or Miſery.
232 *Sic ſubducimur.* Thus our Lives terminate.
233 *Sol ſplendit omnibus.*
The Sun ſhines on all.

---

* At a Charity-School.
† In a Garden.
‖ On a Chimney.

[233] *Si Deus nobiſcum quis contra nos.*
My God and all Things.

234 *Salve domine Anglorum.*
Hail Lord of *Britain.*

235 *Spectator faſtidioſus ſibi moleſtus.*
Envious Spectator, be thy own Tormentor.

236 *Semel elapſum.* Once elapſed.

237 *Tempus ad lucem ducit veritatem.*
Time brings Truth to Light.

238 *Tempus obit, mors venit.*
Time dies, Death reigns.

239 *Tempus fugit.* Time flies.

240 *Tempus vitæ monitor.*
Time is a Memento to Life.

241 *Tenere non potes nec perdere.*
Impoſſible to be kept or loſt.

242 *Tempus me velocius avolans redimite.*
The Rapidity of Time augments its Value.

243 *Tranſit hora ſine mora.*
'Tis impoſſible to ſtop the fleeting Hour.

244 *Tempus rerum imperator.*
Time commands all Things.

245 *Tempus labitur.* Time ſteals away.

246 *Tarde ſed certe.* Slow but ſure.

247 Take Time by the Forelock.

248 Time flies.

249 *Tempus edax rerum.*
Time brings all Things to an End.

250 *Tenere non potes, perdere potes.*
You may waſte, but cannot ſtop me.

251 True as the Dial to the Sun.

252 **Tanquam fumus.* Like Smoke.
Life vaniſhes like Smoke.

---

* On a Chimney.

253 *Tempori pare.* Yield to the Times.

254 *Tempus celerrime aufugit.*
Time paſſes ſwiftly away.

255 *Tempus omnia revelat.*
Time reveals all Things.

256 *Tempore fiunt omnia.*
Time finiſhes all Things.

257 *Tempus vitæ monitor.*
Time is the Monitor of Life.

258 *Tempus breve eſt.* Life is ſhort.

259 Take up the Croſs and follow me.*

260 Time and Tide ſtay for no Man.†

261 Time is precious.

262 *Tempus fugit, mors venit.*
Time's on the Wing, and Death's approaching.

263 *Tot horæ quot vices.*
Every Hour has its Changes.

264 *Truditur dies die.*** One Day ſucceeds another.

265 *Tempora mutantur & nos.*
All Things fluctuate.

266 *Trepide.* In a Hurry.

267 *Umbra Dei.*
The Workmanſhip of the great Architect.

268 *Ut umbra ſic vita.*
Life is fleeting as the Shadow.

269 *Venio ut fur.* I ſteal imperceptibly upon you.

270 *Vigilate & orate, tempus fugit.*
Watch and pray, Time ſteals away.

271 *Via vitæ.* Life's Road.

272 *Vita noſtra eſt inſtar commœdiæ.*
Life often changes Scenes.

---

* On the Face of a Dial, on which is painted St. *Andrew* and his Croſs, on the South Side of St. *Andrew's* Church, in *Holborn.*

† At the *Steel Yard,* facing the *Thames.*

** *HORACE.*

273 *Veritas temporis filia.*
Time is the Father of Truth.

274 *Vehimur properantibus horis*
ad cœlum aut erebum.
The fleeting Hours waft us to Happineſs or Miſery.

275 *Vigilate.* Be vigilant.

276 *Veſtra latet.* Your Fate is uncertain.

277 *Vaneſcit & iterum apparet.*
It vaniſhes and appears.

278 *Verum ſoli.* True to the Sun.

279 *Umbra videt umbram, vive hodie.*
One Shadow gazeth at another.

280 *Una dabit quod negat altera.*
What is denied by one may be ſupplied by another.

281 *Vigor ætatis fluit ut flos veris.*
Life in its greateſt Vigour is altogether Vanity.

282 *Utere præſenti, memor ultimæ.*
If you remember the laſt, you'll improve the preſent.

283 *Umbræ tranſitus eſt tempus noſtrum.*
Our Life reſembles the Shadow that paſſeth away.

284 *Vive memor quam ſis ævi brevis.*
Life how ſhort! Eternity how long!

285 *Ventus quo vult ſpirat.**
The Wind bloweth where it liſteth.

286 *Vita tranſit.* Life paſſeth away.

287 *Verus ſum temporis index.*
I ſhew the Time faithfully.

288 *Vivite, ait fugio.*†
Live, it ſays, I am on the Wing.

289 *Volucri curſu.* With winged Speed.

290 Welcome Chapmen.**

---

* On a Wind Dial.

† *B. Atterbury*, at *Bromley* in *Kent*.

** On a Dial in a Market Place.

291 Work to-day, and play to-morrow.
292 Watch, for you know not the Hour.
293 Watch.
294 *Ζωὴ ἀτμὴ σκιή.* Life's the Spectator of a Shadow.

Upon the Sun-Dial on the High-Church *Wall of* GLASGOW. 295

Our Life's a flying Shadow, God's the Pole;
The Index pointing at him is our Soul;
Death's the Horizon, when our Sun is ſet,
Which will through *Chriſt* a Reſurrection get.

Written on a Sun-Dial in a Circle. 296

Sic petit oceanum Phœbus, ſic vita ſepulchrum,
Dum ſenſim tacita volvitur hora rota:
Secula ſic fugient, ſic lux, ſic umbra, theatrum
Donec ſtelligerum clauſerit una dies.

Afterwards turned into Engliſh:
Thus ſteal the ſilent Hours away,
The Sun thus haſtes to reach the Sea,
And Men to mingle with their Clay.
Thus Light and Shade divide the Year,
'Till the laſt great Day appear
To ſhut the ſtarry Theatre.

ANOTHER.

297 So ſlide the Hours, ſo wears the Day,
Theſe Moments meaſure Life away,
With all its Trains, of Hope and Fear;
'Till ſhifting Scenes of Shade and Light
Riſe to eternal Day, or ſink in endleſs Night,
Where all is Joy, or all Deſpair.

On a Cieling Dial, uſually called a Spot Dial, made at a weſtern Window at Theobald's.

298 Little Sun upon the Cieling,
Ever moving, ever ſtealing
Moments, Minutes, Hours away,
May no Shade forbid thy ſhining,
While the heav'nly Sun declining
Calls us to improve the Day.

Another for a Spot Dial.

299 Shining Spot, but ever ſliding!
Brighteſt Hours have no abiding:
Uſe the golden Moments well;
Life is waſting,
Death is haſting,
Death conſigns to Heav'n or Hell.

ANOTHER.

300 See the little Day-Star moving;
Life and Time are worth improving:
Seize the Moments while they ſtay,
Seize and uſe them,
Leſt you loſe them,
And lament the waſted Day.

ANOTHER.

301 This plainly ſhews to fooliſh Man,
That his whole Life is but a Span.

CHAP. XXIV. *A new Table of the* Elevation of the Pole, *and* Difference of Meridians *from* London.

A *New* and *Correct* Alphabetical Table of the moſt eminent *Cities, Towns, &c.* in the World;* ſhewing at each Place *the Elevation of the Pole,* and the *Difference of their Meridian* from *London.*

☞ The *Elevation of the Pole* ſignifies the ſame Thing as the *Latitude of the Place*; and *the Difference of the Meridian,* the ſame as *the Longitude of the Place.*

Note,

D	ſignifies	*Degrees*	E	ſignifies	Eaſt	*Longitude*
H		*Hours*	W		Weſt	
M		*Minutes*	N		North	*Latitude.*
			S		South	

An Explanation *of the following Table.*

The *Names* of the Places ſtand in an *alphabetical Order*, and thoſe *Names* are always followed by *One* or *Two* more in the ſame Line or Article. Where there is but *One* Name following *that* of the *Place*, it ſignifies what *Kingdom* or *Part of the World* it is ſituated in; as *Athens*, Greece, ſignifies that *Athens* is in Greece: But where there are *Two* Names following the Name of the *Place*, the *Firſt* ſignifies the *Province* or *Diviſion*, and the *Second* the *Kingdom* or Part of the World, as *Aix la Chapelle*, Weſtphalia, Germany, ſignifies that *Aix la Chapelle* is in Weſtphalia, which is a Province of Germany, and ſo of all the reſt.

N. B. The Table of the principal Cities and Towns in *England, Scotland, Ireland,* and *Wales,* is on Page 14, *&c.*

	Latit.		*Dif. Me.*	
	D.	M.	H.	M.
A.				
Adrianople, Turkey, Europe	43	18 N	1	50 E
Agra, a Capital in the Mogul's Empire	29	0 N	5	38 E
Aix, Provence, France	43	4 N	0	23 E
Aix la Chapelle, Weſtphalia, Germany	50	48 N	0	28 E
Aleppo, Syria, Aſia	37	0 N	2	45 E
Alexandria, Egypt, Africa	31	25 N	2	3 E
Alexandretta, Syria, Aſia	37	10 N	2	31 E
Algiers, Barbary, Africa	36	20 N	0	9 E
Alicant, Valencia, Spain	37	45 N	0	1 E
Amſterdam, Holland	52	29 N	0	20 E
Antibes, Provence, France	43	15 N	0	33 E
Antwerp, Brabant	51	16 N	0	17 E
Archangel, Ruſſia	64	30 N	2	41 E
Arica, Peru, South America	18	50 S	4	59 W
Aſtracan, near the Caſpian Sea, Muſcovy	46	50 N	3	26 E
Athens, Greece	37	25 N	1	35 E
Augsburg, Suabia, Germany	47	55 N	0	43 E
B.				
Babylon, Chaldea	34	30 N	3	14 E
Bagdat, Meſopotamia, Aſia	33	0 N	3	2 E
Baldivia, Chili, South America	40	0 S	5	12 W
Barbadoes, Weſt-Indies	13	10 N	3	59 W
Barcelona, Catalonia, Spain	41	10 N	0	8 E
Batavia, Java, Eaſt-Indies	6	5 S	7	6 E
Bayonne, Gaſcony, France	43	30 N	0	5 W
Belgrade, Servia	45	0 N	1	13 E
Belvedre, Naples, Italy	39	35 N	1	6 E
Benevente, Spain	41	55 N	0	21 W
Beneventum, Naples, Italy	41	13 N	1	2 E
Bengal, India	21	0 N	5	12 E
Bergen, Norway	60	0 N	0	22 E
Berlin, Germany	52	10 N	0	52 E
Bern, Switzerland	47	0 N	0	31 E
Bilboa, Biſcay, Spain	43	10 N	0	9 E
Bologne, or *Boulogne*, Italy	44	20 N	0	48 E
Bonn, Lower Rhine, Germany	50	30 N	0	30 E
Boiſleduc, Brabant, Flanders	51	30 N	0	20 E
Boſton, New-England	42	10 N	4	28 W
Bourdeaux, Guienne, France	44	55 N	0	3 E
Bourges, Orleanois, France	46	54 N	0	10 E
Brandenburgh, Pruſſia, Germany	52	10 N	0	50 E
Breſt, Bretagne, France	48	34 N	0	18 E
Breda, Spaniſh Provinces	51	30 N	0	17 E
Breſlaw, Bohemia, Germany	51	5 N	1	6 E
Brill, Holland	51	55 N	0	25 E
Brindiſi, Naples, Italy	40	48 N	1	13 E
Brunſwick, Germany	51	55 N	0	46 E

Bruges,

	Latit.		Dif. Me.	
	D.	M.	H.	M.
Bruges, Flanders	51	15 N	0	12 E
Bruſſels, Flanders	50	48 N	0	16 E
Buda, Lower Hungary	47	0 N	1	8 E
C.				
Cadiz, Andaluſia, Spain	37	5 N	0	23 W
Caen, Normandy, France	49	5 N	0	22 W
Cagliari, Sardinia, Mediterranean	39	10 N	0	38 E
Cairo, Egypt, Africa	30	10 N	2	6 E
Calais, France	51	0 N	0	8 E
Calecute, Eaſt-Indies	11	0 N	4	59 E
Cambray, France	50	10 N	0	13 E
Candia, in Candia-Iſland	34	55 N	1	39 E
Candea, Ceylon, Eaſt-Indies	7	30 N	5	22 E
Cape of Good Hope	34	25 S	1	6 E
Cartagena, Spaniſh Weſt-Indies				
Carthagena, Murcia, Spain	37	0 N	0	2 E
Carthage, Barbary, Africa	35	0 N	0	44 E
Caſal, Milan, Italy	45	5 N	0	34 E
Catanea, Sicily	37	20 N	1	1 E
Ceuta, Africa	35	50 N	0	23 W
Charles-Town, in Carolina	32	30 N	5	24 W
Chriſtianſtad, Gothland, Sweden	56	35 N	0	58 E
Clermont, Lionois, France	45	40 N	0	13 E
Cleves, Weſtphalia, Germany	51	40 N	0	25 E
Cochin, Malabar, Aſia	10	0 N	5	1 E
Cochin-China, Eaſt-Indies, Aſia	13	0 N	7	8 E
Cologne, Germany	50	40 N	0	29 E
Conſtantinople, Romania, Turkey	41	6 N	1	59 E
Copenhagen, Zealand, Denmark	55	40 N	0	50 E
Corinth, Morea, Turkey	38	0 N	1	30 E
Cracow, Poland	50	15 N	1	23 E
Cremona, Milan, Italy	45	10 N	0	42 E
Cuſco, Peru, South America	12	20 S	4	48 W
Cyprus Iſland, Levant	35	0 N	2	16 E
D.				
Dantzick, Poland	54	25 N	1	18 E
Darmſtadt, Upper Rhine, Germany	49	30 N	0	37 E
Delft, Holland	52	10 N	0	17 E
Derbent, near the Caſpian Sea	42	0 N	3	20 E
Deventer, United Provinces	51	56 N	0	24 E
Deux Ponts, Upper Rhine, Germany	49	10 N	0	29 E
Doway, Flanders	50	12 N	0	14 E
Dreſden, Saxony, Germany	51	6 N	0	55 E
Drontheim, Norway	63	0 N	0	41 E
Dunkirk, France	51	7 N	0	10 E
Durazzo, Albania, Turkey	40	40 N	1	11 E

	Latit.			Dif. Me.		
	D.	M.		H.	M.	
E.						
Elbing, Poland	54	20	N	1	22	E
Embden, Weſtphalia, Germany	53	10	N	0	29	E
Epheſus, Natolia, Aſia	37	50	N	1	50	E
F.						
Ferrara, Italy	44	45	N	0	49	E
Fez, Barbary, Africa	33	15	N	0	24	W
Finale, Genoa, Italy	44	10	N	0	34	E
Florence, Tuſcany, Italy	43	40	N	0	47	E
Fort St. George, Eaſt-Indies	13	0	N	5	20	E
Frankfort on the Oder, Germany	52	28	N	0	58	E
Frankfort on the Main, Germany	49	45	N	0	39	E
Frieburg, Suabia, Germany	47	50	N	0	33	E
Furnes, Flanders	51	15	N	0	11	E
G.						
Gallipoli, Romania, Turkey	40	55	N	1	53	E
Gelders, Gelderland	51	15	N	0	26	E
Geneva, Savoy, Italy	46	15	N	0	25	E
Genoa, Italy	44	25	N	0	37	E
Ghent, Flanders	51	6	N	0	14	E
Gibraltar, Andaluſia, Spain	35	30	N	0	19	E
Glatz Bohemia, Germany	50	30	N	1	7	E
Goa, Eaſt-Indies	15	22	N	4	58	E
Gombroon, Perſian Gulf	7	10	N	3	44	E
Gottenburgh, Sweeden	57	30	N	0	48	E
Granada, Granada, Spain	36	20	N	0	11	E
Graveling, Flanders	51	4	N	0	10	E
Grenoble, Dauphine, France	45	10	N	0	23	E
Grodno, Lithuania, Poland	53	25	N	1	40	E
Groeningen, Holland	53	5	N	0	23	E
H.						
Hague, Holland	52	10	N	0	16	E
Hall, Suabia, Germany	49	6	N	0	41	E
Hamburgh, Denmark	53	30	N	0	40	E
Hanaw, Upper Rhine, Germany	50	3	N	0	41	E
Hanover, Saxony, Germany	52	16	N	0	36	E
Harlem, Holland	52	25	N	0	17	E
Heidelburg, Lower Rhine, Germany	49	12	N	0	35	E
Helmſtat, Saxony, Germany	51	52	N	0	49	E
Hulſt, Flanders	51	20	N	0	19	E
I.						
James Town, Virginia, North America	37	10	N	5	0	W
Jeruſalem, Paleſtine, Aſia	32	44	N	2	21	E
Ingolſtat, Bavaria, Germany	48	32	N	0	52	E
Iſpahan, Ancient Perſia, Aſia	33	0	N	3	33	E
Juliers, Weſtphalia, Germany	50	20	N	0	27	E
K.						
Kaminaick, Podolia, Poland	49	20	N	1	38	E

Kargapol,

	Latit.		Dif. Me.	
	D.	M.	H.	M.
Kargapol, Ruſſia	61	30 N	2	49 E
Kexholm, Finland, Sweeden	61	20 N	2	4 E
Koningsburgh, Pruſſia, Poland	54	55 N	1	29 E
Konizeck or *Konioz*, Poland	54	15 N	1	15 E
L.				
Landau, Suabia, Germany	48	50 N	0	33 E
Laodicea, Natolia, Aſia	38	10 N	1	58 E
Lariſſa, Theſſaly, Turkey in Europe	39	30 N	1	29 E
Larta, Epirus, Greece, now Turkey	39	0 N	1	17 E
Lawenburgh, Saxony, Germany	53	20 N	0	43 E
Legorn or *Leghorn*, Tuſcany, Italy	43	40 N	0	45 E
Lepanto, Achaia, Turkey	38	30 N	1	23 E
Lerida, Catalonia, Spain	41	15 N	0	3 E
Leuwarden, Weſt Frieſland, Holland	53	0 N	0	26 E
Leyden, Holland	52	10 N	0	14 E
Leipſick, Germany	50	50 N	0	51 E
Leige, Spaniſh Provinces	50	25 N	0	22 E
Lima, Peru, South America	11	30 S	5	15 W
Liſle, Flanders	50	40 N	0	11 E
Lisbon, Portugal	38	45 N	0	33 W
Livorn, ſee *Leghorn*				
LONDON, Metropolis of England	51	32 N	0	0
Loretto, Tuſcany, Italy	43	36 N	0	59 E
Louvain, Spaniſh Provences	50	40 N	0	19 E
Lubeck, Holſtein, Denmark	54	10 N	0	45 E
Lucca, Tuſcany, Italy	43	50 N	0	44 E
Lunden. Gothland, Sweeden	55	30 N	0	54 E
Luxemburgh, Saxony, Germany	53	10 N	0	43 E
Luxemburgh, France	49	20 N	0	25 E
Lions, Lionois, France	45	40 N	0	19 E
M.				
Madagaſcar, Africa	19	29 S	2	56 E
Madrid, New Caſtile, Spain	40	10 N	0	14 W
Maeſtrecht, Spaniſh Provinces	50	34 N	0	23 E
Magdeburgh, Saxony, Germany	51	45 N	0	50 E
Majorca, in the Mediterranean	39	0 N	0	10 E
St. Maloes, Bretagne, France	48	38 N	0	9 W
Malaga, Granada, Spain	36	0 N	0	16 W
Malta, near Sicily, Mediterranean	35	50 N	0	56 E
Malacca, Eaſt-Indies	2	8 N	6	42 E
Mantua, Italy	45	16 N	0	47 E
Marſeilles, Provence, France	43	15 N	0	23 E
Mecca, Arabia Felix	21	30 N	2	34 E
Mechlin or *Malines*, Spaniſh Provinces	50	50 N	0	9 E
Medina, Arabia Felix	24	15 N	2	22 E
Mentz or *Mayence*, Germany	49	44 N	0	33 E
Meſſina, Sicily	38	10 N	1	3 E

	Latit.		Dif. Me.	
	D.	M.	H.	M.
Metz, Lorain, Germany	48	50 N	0	24 E
Mexico, North America	10	0 N	6	56 W
St. Michael, ſee Arch-Angel				
Milan, Italy	45	28 N	0	38 E
Minski, Lithuania, Poland	54	6 N	1	53 E
Minorca Iſland, Mediterranean	39	10 N	0	16 E
Mittau, Courland	56	25 N	1	40 E
Modena, Italy	44	30 N	0	47 E
Montpelier, Languedoc, France	43	28 N	0	16 E
Mons, Spaniſh Provinces	50	20 N	0	15 E
Morlaix, Bretagne, France	48	38 N	0	15 W
Moſcow, Capital, of Muſcovy	55	30 N	2	38 E
Munſter, Weſtphalia, Germany	51	45 N	0	31 E
Munchen, or *Munich*, Bavaria, Germany	47	45 N	0	46 E
N.				
Namur, Flanders	50	10 N	0	23 E
Nancy, Lorrain, France	48	32 N	0	27 E
Nantz, Bretagne, France	47	12 N	0	6 E
Nankin, or Nanquin, China	31	0 N	7	54 E
Naples, Italy	41	45 N	0	59 E
Narva, Livonia, Sweden	58	55 N	2	2 E
Narbonne, Languedoc, France	42	50 N	0	12 E
Naſſaw, Upper Rhine, Germany	50	0 N	0	32 E
Newmark, Tranſylvania	47	30 N	1	26 E
Nice or *Nizza*, Piedmont, Italy	43	40 N	0	29 E
Niſmes, Languedoc, France	43	30 N	0	18 E
Notteburg, Ingria, Sweden	60	0 N	2	5 E
Novogrod, Weliki, Ruſſia	58	10 N	2	9 E
Nuremberg, Franconia, Germany	49	0 N	0	45 E
O				
Olmutz, Bohemia, Germany	49	32 N	1	10 E
St. Omers, Flanders	50	50 N	0	9 E
Orange, Provence, France	44	10 N	0	19 E
Oran, Barbary, Africa	35	33 N	0	0 E
Oreſcriſs, ſee Notteburg				
Orleans, Orleanois, France	47	45 N	0	7 E
Orvieto, Papacy, Italy	42	27 N	0	53 E
Otranto, Naples, Italy	40	52 N	1	15 E
Oudenard, Flanders	50	46 N	0	13 E
Oviedo, Auſtria, Spain	43	10 N	0	23 W
P.				
Padua, Italy	35	32 N	0	50 E
Palermo, Sicily	37	26 N	2	30 E
Panama, America	1	10 S	5	30 W
Paris, France	48	45 N	0	9 E
Parma, Italy	44	42 N	0	44 E
Pavia, Italy	45	12 N	0	38 E

	Latit.		*Dif.Me.*	
	D.	M.	H.	M.
Pekin, China	39	52 N	7	23 E
Fergamos, Natolia, Aſia	37	50 N	1	57 E
Peterſburg, Ruſſia	59	25 N	1	59 E
Philadelphia, Natolia, Aſia	38	35 N	1	58 E
Piſa, Tuſcany, Italy	43	55 N	0	45 E
Placentia, Parma, Italy	44	50 N	0	41 E
Pleſkow, Ruſſia	58	10 N	2	16 E
Ploozko, Poland	52	35 N	1	22 E
Poictiers, Orleanois, France	46	30 N	0	1 E
Porto or *Oporto*, Portugal	40	52 N	0	31 W
Port Royal, Jamaica	17	40 N	5	4 W
Prague, Bohemia, Germany	50	0 N	0	58 E
Q				
Quebeck, Canada	47	10 N	4	41 W
St. Quintin, Picardy, France	49	50 N	0	12 E
R.				
Ratiſbon, Bavaria, Germany	48	34 N	0	49 E
Ravenna, Italy	44	25 N	0	51 E
Rennes, Bretagne, France	48	12 N	0	6 E
Reims, Champagne, France	49	20 N	0	16 E
Rhodes Iſland, Archipelago	35	30 N	1	57 E
Riga, Livonia	57	0 N	1	39 E
Rochel, Orleanois, France	45	55 N	0	3 E
ROME, Italy	42	8 N	0	52 E
Rotterdam, Holland	51	50 N	0	17 E
Roven or *Roan*, Normandy, Franc	49	15 N	0	5 E
S				
Saltsburgh, Bavaria, Germany	47	20 N	0	54 E
Salamancha, Leon, Spain	40	45 N	0	19 E
Salonichi, Theſſalonica, Turkey	40	42 N	1	31 W
Salerno, Naples, Italy	41	8 N	1	3 W
Sallee, Africa	22	25 N	0	31 E
Samarcand, Tartary	40	0 N	4	15 E
Santillana, Auſtria, Spain	43	10 N	0	14 E
Saragoſa, Arragon, Spain	41	20 N	0	3 E
Sardis, Natolia, Aſia	38	10 N	1	56 E
Savona, Genoa, Italy	44	25 N	0	36 E
Scanderoon, ſee Alexandretta	37	10 N	2	31 E
Schaffhauſen, Switzerland, Germany	47	28 N	0	35 E
Segovia, Old Caſtile, Spain	40	36 N	0	15 E
Sens, Champagne, France	48	0 N	0	13 E
Setines, ſee Athens				
Seville, Andaluſia, Spain	37	0 N	0	20 W
Siam, Eaſt-Indies	14	5 N	6	43 E
Slezwick, Denmark	55	57 N	0	39 E
Smolenſko, Muſcovy	54	55 N	2	14 E
Smyrna, Natolia, Aſia	38	4 N	1	36 E

Soiſſons,

	Latit.		Dif. Me.	
	D.	M.	H.	M.
Soiſſons, France	49	20 N	0	14 E
Sophia, Bulgaria, Turkey	42	32 N	1	30 E
Spalato, Dalmatia, Turkey	43	20 N	1	2 E
Spires, Upper Rhine, Germany	49	0 N	0	33 E
Spoletto, Italy	42	28 N	0	55 E
Stockholm, Sweeden	59	30 N	1	16 E
Strasburg, Upper Rhine, Germany	48	17 N	0	31 E
Sultzback, Bavaria, Germany	49	10 N	0	47 E
Surat, India	21	30 N	4	47 E
Syracuſe, Sicily	35	15 N	1	0 E
T.				
Tangier, Barbary, Africa	35	45 N	0	24 W
Tarante, Naples, Italy	40	40 N	1	11 E
Tarragon, Catalonia, Spain	40	55 N	0	5 E
Temeſwaer, Hungary	45	30 N	1	15 E
Tetuan, Fez, Africa	35	30 N	0	22 E
Thebes, ſee Stives				
Tholouſe, or Toulouſe, Languedoc, France	43	15 N	0	7 E
Thorn, Poland	53	0 N	1	18 E
Thyatira, Natolia, Aſia	38	28 N	1	54 E
Tokay, Hungary	48	12 N	1	15 E
Toledo, New Caſtile, Spain	39	30 N	0	14 W
Tortoſa, Catalonia, Spain	40	34 N	0	2 E
Torneo, or *Torno*, Lapland	65	50 N	1	34 E
Tours, Orleanois, France	47	10 N	0	4 E
Toulon, Provence, France	43	0 N	0	25 E
Tournay, Flanders	50	35 N	0	14 E
Trent, Auſtria, Germany	45	50 N	0	46 E
Treves, or *Triers*, Lower Rhine, Germany	49	30 N	0	27 E
Tripoli, Barbary, Africa	33	5 N	0	55 E
Tunis, Barbary, Africa	35	30 N	0	51 E
Turin, Piedmont, Italy	44	50 N	0	31 E
V.				
Valencia, Valencia, Spain	39	15 N	0	1 E
Valladolid, Old Caſtile, Spain	41	28 N	0	15 W
Vendoſme, Orleanois, France	47	45 N	0	4 E
Venloe, Gelderland	51	10 N	0	25 E
Venice, Italy	45	36 N	0	51 E
Verdun, Lorrain, Germany	49	10 N	0	21 E
Verona, Venice, Italy	45	25 N	0	48 E
Vienna, Auſtria, Germany	48	12 N	1	7 E
Vienne, Dauphine, France	45	26 N	2	43 E
Ulm, Suabia, Germany	47	55 N	0	41 E
Upſal, Sweeden	59	55 N	1	14 E
Utrecht, Holland	52	0 N	0	20 E
W.				
Warſaw, Poland	52	10 N	1	28 E

Waterford,

	Latit.		Dif. Me.	
	D.	M.	H.	M.
Waterford, Ireland	53	0 N	0	29 W
Weſel, Weſtphalia, Germany	51	32 N	0	26 E
Wiberg, Jutland, Denmark	56	25 N	0	37 E
Wittenbergh, Saxony, Germany	51	28 N	0	53 E
Wolfenbuttel, Brunſwick, Germany	51	50 N	0	43 E
Wormes, Germany	49	12 N	0	34 E
Wurtsburg, or *Wirtsburg*, Franconia, Germany	49	20 N	0	41 E
Y.				
Yvica, Mediterranean	38	40 N	0	5 E
Z.				
Zell, Lunenburgh, Germany	52	30 N	0	42 E
Zolnock, Hungary	47	58 N	1	13 E
Zurick, Switzerland, Germany	47	15 N	0	33 E
Zutphen, Gelderland, Holland	52	4 N	0	24 E

CHAP. XXV. *Concerning the* Motion *of the* Hands *of a Clock or Watch, as it repreſents the* Motion *of the* Sun *and* Moon.

FOR a Concluſion of this Work, I ſhall here ſhew my Reader how naturally the *two* Hands of a *Clock* or *Watch* repreſent the Motions of the *Sun* and *Moon:* For as there are *twelve* Calendar Months, and *twelve* Signs in the Zodiack, ſo alſo are there *twelve* Hours upon the Dial Plate of a *Clock* and *Watch*. But as the *Moon* makes *thirteen* Conjunctions with the *Sun* in *one* Year, that is, in the Time the Sun *apparently* moves once round the Heavens, ſo the *Minute-Hand* of a Clock or Watch makes but *eleven* Conjunctions with the *Hour-Hand* in the Time it moves *once* round. For let the *Hour-Hand* repreſent the *Sun*, and the *Minute-Hand* the *Moon*, at 12 *a-clock* they are *always* together, then they both moving forward, when the *Minute-Hand* comes again to 12, it doth not find the *Hour-Hand* there, but is moved *one eleventh* Part of the whole Revolution further; therefore the *Minute-hand* muſt go 5 Min. 27 Sec. 16 Thirds, 21 Fourths, 49 Fifths $\frac{1}{11}$, before it make the *next Conjunction* with the *Hour-hand.* And

Juſt ſo it is with the *Sun* and *Moon;* for ſuppoſing the *new Moon;* to be upon the 21ſt Day of *March* in the very beginning of *Aries,* they both moving forward according to the order of the Signs.

When the *Moon* comes again to the very *beginning* of *Aries,* ſhe doth not find the *Sun* there, he is moved 26 Deg. 55 Min. 46 Sec. more to the *Eaſt* in the *Ecliptick,** ſo that the next Conjunction of the *Sun* and *Moon* will be made in *Aries* 29 Deg. 6 Min. 25 Sec. 12 Thirds, according to their *middle Motions;* and the next or *ſecond new Moon* would be made in *Taurus* 28 Deg. 12 Min. 50 Sec. 24 Thirds; the *Third* in *Gemini* 27 Deg. 19 Min. 15 Sec. 36 Thirds; the *Fourth* in *Cancer* 26 Deg. 25 Min. 40 Sec. 48 Thirds, *&c.* every *new Moon* exceeding the Place of the foregoing by 29 Deg. 6 Min. 25 Sec. 12 Thirds, but they do not move equally as both the Hands of a *Clock* or *Watch.* Therefore the above *equal* Law of the *Sun* and *Moon* is not exactly obſerved; however, this may ſerve well enough to give an *Idea* of the *new Moons,* how it is nothing elſe but the paſſing of the *Moon* by the *Sun,* as the *Minute-hand* of a *Watch* doth by the *Hour-hand,* as repreſented by the following Table.

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* See my *Uranoſcopia* page 166.

A New

A New *and* Correct *Table, ſhewing the* exact *Time that the* Hands *of a Clock or Watch* meet *through* one Revolution, *or the whole* 12 *Hours upon the* Dial Plate *of a Clock, &c.*

N°.	Hours	H	′	″	‴	iv	v
1	1	1	5	27	16	21	49 $\frac{1}{11}$
2	2	2	10	54	32	43	38 $\frac{2}{11}$
3	3	3	16	21	49	5	27 $\frac{3}{11}$
4	4	4	21	49	5	27	16 $\frac{4}{11}$
5	5	5	27	16	21	49	5 $\frac{5}{11}$
6	6	6	32	43	38	10	54 $\frac{6}{11}$
7	7	7	38	10	54	32	43 $\frac{7}{11}$
8	8	8	43	38	10	54	32 $\frac{8}{11}$
9	9	9	49	5	27	16	21 $\frac{9}{11}$
10	10	10	54	32	43	38	10 $\frac{10}{11}$
11	12	12	00	00	00	00	00

EXPLANATION.

The firſt Column to the *left Hand* ſhews the Number of *Conjunctions* of the *Hour* and *Minute-hand*, the *ſecond* contains the *Hours*, the *third* the exact Times of their *meeting*.

As for Example.

The *two Hands* are *together* at 12 a-clock, and the *next Time* they will be *together* will be at 5 M. 27 Sec. 16 Thirds, 21 Fourths, 49 Fifths $\frac{1}{11}$ paſt one, the *third* Meeting will be at 10 M. 54 S. *&c.* paſt 2, the *fourth* at 16 M. 21 S. *&c.* paſt 3 a-clock, *&c.* as in the Table, and this is plain enough without any more Examples.

CHAP.

CHAP. XXVI. *Of* PAINTING Sun Dials, *and firſt of the Planes or Surfaces on which* DIALS *are to be drawn.*

DIAL Planes are of *two* Sorts; *firſt*, ſuch as are made on the Wall of a Building; or *ſecondly*, ſuch as are drawn on Tables of Wood, vulgarly called *Dial-Boards*.

The *firſt Sort*, if they are made on *Brick-Work*, is done by plaiſtering on the Wall with Lime, Sand and Hair, mixed; this muſt be well drenched with *Linſeed Oil*, after it is dry, *i.e.* as long as it will drink any; and then painted with Oil and White-Lead, that it may be durable.

But a better way is to temper the Lime, Sand and Hair with Ox Blood, which will be no great Charge, but of great Advantage; for this Mixture will equal in Time the hardneſs of a Free-Stone, and keep the Surface as free from the Injuries of Weather; but you muſt afterwards paint it white. The following Method is ſtill preferable.

To make an exceeding ſtrong Cement *or* Plaiſter, *with which to form any Dial Plane upon the* Side of a Houſe *or* Wall, *which will endure the Weather, not inferior to Stone.*

Take *Lime* and *Sand*, and temper it with *Linſeed Oil* to the Conſiſtency of *Mortar*, or common Plaiſter, and ſpread it upon the Wall to a *competent* Thickneſs, and it will become as hard as a Stone, and laſt many Ages; and upon this you may deſcribe a Dial, and put on the Lines, Figures and Furniture, as hereafter is directed.

Note, If you are in the Country, remote from any Opportunity of getting *Linſeed Oil*, you may make it with *ſkimmed Milk*, which will be much ſuperior to Plaiſter made with Lime, Hair and Water.

If you are to draw a Dial upon a *Stone*, the beſt Way is to *drench* the Stone with *Linſeed Oil* and *White-Lead* mixed *very thin*, till it will drink in no more; then ſhall the *Dial* you paint upon it, laſt longer, and be the better prepared againſt the Ruins of Time.

Now for Tables or *Dial Boards* of *Wood*, they being the moſt common, I ſhall give ſuch Directions for making them, as have been always found moſt profitable and fit for the Purpoſe.

The beſt Woods for this Purpoſe, are the *cleareſt Wainſcot*, and *yellow Fir*, provided it is clear of dead Turpentine Knots; there is not much Difference between theſe two Woods, as to their Alteration by the Weather, they being both ſubject to ſplit in caſe they *are bound*, and have not free Liberty to *ſhrink* with dry Weather, and *ſwell* with Wet, though as to their laſting, Oak ſeems preferable; though good *yellow Fir* will laſt the Age of an ordinary Man, if well ſecured, as Things of this Nature ought to be.

In working either of theſe Kinds of Woods, the Boards ought firſt to be cut to ſuch a Length as you intend your *Dial* Board ſhould be, and ſo many of them as may make up the Breadth deſigned, and let them be joined on the Edges, and plained on both Sides, and afterwards ſet to dry.

For it has been obſerved, that though Boards have lain in a Houſe ever ſo long, and are ever ſo dry, yet when they are thus ſhot and plained, they will ſhrink afterwards beyond Belief, if kept dry.

When you think they are dry enough, and will ſhrink no more, let them be ſhot again with good Joints, and let every Joint be ſecured with wooden *Dove-Tails*, let in a-croſs the Joint in the *Backſide*; let this be done after the Boards are glued together and well dried: after it has been thus glued, and the Joints are ſufficiently dry, then let the *Face* of the Board be well plained and tried every Way that it may be both *ſmooth* and *true*, and the Edges ſhot true and all of a Thickneſs, as Pannels of Wainſcot are commonly wrought.

The *Edges* muſt be true and even, that they may fit into the *Rabit* of a Moulding, put round it, juſt as a Pannel of Wainſcot does in its Frame.

This Method will give Liberty to the Board to *ſhrink* without tearing; whereas Mouldings that are nailed round the Edges, as the common Way is, do ſo reſtrain the Motion of the Wood, that it cannot *ſhrink* without tearing; but Boards made this Way will laſt a long Time, without either parting in the Joints or ſplitting in the Wood.

Dials are ſome Times drawn on Planes lined with *Copper* or *Lead*, that they may be free from ſplitting or tearing; but a Board *(if it be made as before directed)* is to be prefered in many Reſpects. As *firſt*, In that it is much cheaper. *Secondly*, Both *Lead* and *Copper* will ſwell a little with the Heat of the Sun, and in Time will grow *hollow outwards*, or become *convex* inſtead of a perfect *Flat*, which will much pervert the Truth of its Shadow. And, *thirdly*, The Colours will be apt to peel from the Metal, and the Dial will by that means be in danger to be ſooner defaced, than if it were painted upon a wooden Plane.

To make the beſt Glue *for gluing the Joints of Boards for Dials.*

Take a *Quart of Milk* (but ſome have prefered Water) that has ſtood ſo long and been ſkimmed ſo often that no more Cream will ariſe; and when ſkimmed very clean boil it a little in a *leaden Pot*, and if any ſkum yet ariſe be ſure to take it clean off; then put into the Milk about *half a Pound* of good Glue cut in ſmall Bits, which will ſoon melt: boil it gently on a ſoft Fire to *a good Body*, but not to be too thick nor too thin; then take it off the Fire and keep it for Uſe. *Note*, Care muſt be taken in the Boiling that it do not *burn to the Sides of the Pot*, for that takes away much of the Strength of the Glue; but if it be made with due Care, it binds beyond any other Glue, and it is better able to reſiſt the Weather, and therefore the fitteſt for gluing Boards for Sun Dials.

Care muſt be taken that your Glue be not made *too thin*, for if it be, the Wood will *ſo drink it up* that it will not be of *a ſufficient Body* to bind the Parts together; on the contrary, if it be *too thick*, it will not give Way for the Joint to *ſhut cloſe enough* to be ſtrongly joined; for though it is Glue that makes the Joints ſtick, yet where there is ſo much of it that the Joint cannot cloſe exactly, it will never hold firmly.

Whenever you uſe your Glue take care that it *be thoroughly hot*, for Glue that is not hot never takes firm hold on the Wood.

You muſt alſo take great Care that the Boards you are to glue have not been touched with *Oil* or *Greaſe*; for in ſuch Places the Glue will never take hold, although after a Thing is once glued faſt, no Greaſe nor Oil can hurt it.

The Glue being ready, and the Joints of the Board ſhot true, ſet *both* the Faces of the Joint cloſe together, and both alſo *turned upward*; then dip a Bruſh in the Glue and beſmear the Faces of both Joints *as quick as poſſible*, then clap the two Faces of the Joint together, and *ſlide or rub them long ways* one upon another two or three Times to ſettle them cloſe, and ſo let them ſtand till they are firm and dry.

To prepare your Oil *for laying on the Colours upon Dials.*

Take *One* Gallon of *Linſeed Oil* and ſet it upon a *Charcoal Fire*, and when it is about to boil put into it *two Pounds of Red Lead*, and let it boil together for *about an Hour*; but the beſt Way to know when it is boiled enough, is to take a little of it out and let it cool, and then if it *ropes like thin Tar*, it is enough: This done, put a *lighted Paper* to it, and ſet it on Fire to conſume the greaſy Part of it, which will be done in a Minute or two, more or leſs, according to the Quantity of your Oil; and when it has burnt *long enough* clap a Cloth or any other Thing cloſe over it, and extinguiſh the Fire; after which let it *cool* and *ſettle*, then decant the *clear Oil* from the Dregs, and keep it *in a Bladder* for Uſe.

This is called *drying Oil*, and with this the ſeveral Colours are to be ground in order to paint, ſo as *to endure the Weather*; but you muſt obſerve that your Colours are *thoroughly dry* before they are *expoſed*. The ſeveral Colours I ſhall deſcribe hereafter.

N. B. The *above Method* of making the *drying Oil* has one Inconvenience in it, that it makes the Oil of a *deep reddiſh Colour*, which in ſome Caſes may alter the *Nature* and *Beauty* of ſome Colours, as *Whites*, which are liable to become *Yellow*; alſo

Blues may by this Means become *greeniſh*; to prevent which, *in the preparing of your Oil*, inſtead of *Red Lead* uſe *Letharge of Gold.*

Of Colours *uſed in Painting* Sun-Dials.

The Colours generally uſed in Painting Sun Dials are:

For *White*, Ceruſe and White Lead.

For *Black*, Lamp-Black, Ivory-Black, Charcoal, and Sea-Coal Black.

For *Red*, Red Lead, Vermillion and Cinnabar Lak.

For *Green*, Verdigreaſe.

For *Blue*, Indigo, blue Bice, blue Verditer and Smalt.

For *Yellow*, yellow Oker, and yellow Pink.

For *Brown*, Spaniſh Brown.

With the above Colours you may *compound* Variety of other Colours, *viz.*

An *Aſh Colour* is made by mixing a *little* Lamp-Black with White.

A *Purple* is made by mixing Cinnabar Lak and blue Bice.

A *Carnation* is made by mixing Cinnabar Lak and White.

A *Green* is made by mixing blue Bice with yellow Pink. N. B. Any Blue and Yellow make a *Green* of ſome Degree or other.

A *Light Blue* is made by mixing blue Bice and White.

A *Lead Colour* is made by mixing Indigo with White.

A lively *Graſs Green* is made by mixing Verdigreaſe with yellow Pink.

And by this Means may ſeveral other Colours be compounded and made *lighter* or *darker* at Pleaſure, as a little Practice will make evident.

To prepare *the Colours for Painting Sun-Dials.*

Before you proceed to the painting of Sun Dials in their ſeveral Colours, it is firſt neceſſary that they be *primed*, that is, painted *two* or *three* Times over with Oil, and Colour prepared for that Purpoſe, to fill up the Cavities which may (after plaining) remain in the Wood, and to make it perfectly plain, and the more capable to receive and retain other Colours; and of all Priming *Spaniſh Brown* is reckoned to be the chief; for, not to mention its Cheapneſs, it *dries kindly*, and gives the Oil a ſufficient Time to penetrate into the Wood: and conſequently both reſiſts the Weather, and alſo freely receives all other Colours which are laid upon it: it is of itſelf of a *Horſe-fleſh Colour*, and (beſides its Uſefulneſs in priming) is a *natural Shadow* for *Vermilion*, and may be made lighter or darker, according to the greater or leſs Quantity of *White* mixed with it; though in priming, it requires not any Mixture, but only the Oil itſelf.

In *preparing* the *Spaniſh Brown* for priming, grind it very well with the afore-mentioned *drying Oil*, and make it for the *firſt Priming* ſomewhat *thinner* than you would do it for painting, that it may more eaſily penetrate into the Wood; which being dry, do it over a *ſecond Time* with the ſame Mixture, only mix it a *little thicker*; and letting that dry, do it a *third Time*, mixing your Colour *thicker* every Time; and take Care in the Priming, not only to rub the Bruſh with the Priming all over the Plane, both on the *Back*, as well as on the *Foreſide* and *Edges*, the better to preſerve it, but alſo to *bob* it againſt it, that the Priming may be ſure to pierce into all the Cavities or Pores of the

Wood: when this laſt Time of colouring with your Priming is dry, then colour the *Face* of the Plane over with *white Lead*, and when it is dry do it over again *three* or *four Times* more ſucceſſively, after each drying; and ſo will the *Face* of your Plane be of a beautiful white Colour, and it will alſo be ſufficiently defended againſt the Fury and Violence of the *Weather* for many Years; when the laſt colouring of your white is dry, your Plane is ready for laying on the Colours, *viz.* painting the *Hour Lines*, or what *Ornament* or *Furniture* you think fit to have upon it.

Observe as a general Rule, that priming is to be mixed or tempered *thin*, but Colours for Lines or Figures to endure the Weather, muſt be tempered *thicker*, the better to reſiſt the Fury of ſtormy or moiſt Weather.

If you are only for making a common *Sun Dial, theſe* four *Sorts of Colours will be ſufficient.*

1. *Spaniſh Brown*; which prepare, and therewith *prime* your Dial, as before directed.

2. *White Lead*, well ground in Oil; with which, after the Priming is *thoroughly dry*, go over it three or four Times, letting it dry between every Time; which not only makes a beautiful white Ground, but fortifies it yet more againſt the Fury of the Weather.

3. *Lamp-Black*, for drawing the *Hour Lines* and *Figures*.

4. *Vermilion*, for drawing the *Parallels of Declination*, or what other *Furniture* you think fit to put upon it.

The *Spaniſh Brown*, *Lamp-Black* and *Vermilion*, are all to be ground in the *drying Oil*, deſcribed in Page 132; and for the *White Lead*, it is to be uſed in the ſame Manner; only in making *drying Oil* for *White Lead*, inſtead of *Red Lead*, uſe *Litharge of Gold*, and proceed as before.

But if you would have your Dial more rich, you muſt firſt conſider, what Colours you reſolve to have your Lines, Figures, *&c.* to be, and *upon what Ground* your determined Colours will appear moſt beautiful. As,

1. *Gold* appears beſt upon a *Blue* Ground, and indifferently upon a *Red.*

2. *Blue* and *Green* appear beſt upon *Yellow* and *White.*

3. *Red* ſets off with *Yellow*, *White*, *Blue*, or *Green.*

4. *Yellow* ſets off with *Black*, *Blue*, and *Red.*

Beſides the Directions given already for *preparing* and *laying on* common Colours, it will be neceſſary to ſpeak of the *laying on* the more rich and beautiful Colours; and firſt of *Gold.*

To make Gold Size, *with which you deſign to lay on Leaf Gold.*

Take *yellow Oker*, and grind it with *Water* on a Stone with a Muller, till it be *very fine*, and then lay it *to dry*, and grind it with the afore-mentioned *drying Oil*, as you would grind other Colours, obſerving to put ſo much of each, that it may be of a *competent Stiffneſs* to work well, and of ſuch a Body, that it may ſettle itſelf ſmooth when laid on, but not *ſo thin* as to run; and take care to grind it *very fine*, and it will add the greater Beauty to your *Gold* that is to be laid on with it.

To lay Leaf-Gold *on an* Oily Size, *or to make any Lines, Figures,* &c. *of Leaf Gold upon your Dial.*

Draw your Lines, Figures, or Letters, or what you think fit to have in Gold, with *Gold Size*, (above-mentioned;) which dry ſo, that when you touch it with your Finger it will *ſtick a little* to it, but the Colour not *come off*; for if the Colour *comes off* on the Finger, then it is not dry enough, and muſt be let alone a little longer; for if you ſhould then lay the Gold on, it would drown it ſo that it would be worth nothing; and on the other Hand if the Size ſhould be ſo dry as to hold your Finger, as it were to it, then is it too dry, and the Gold will not take, for which there is no Remedy but new ſizing: therefore you muſt watch that it be not too wet or too dry. Then cut your Leaf Gold as near as you can, into the Form you would have it, whether of Figures, Letters, Lines, &c. (taking care to cut it rather *too large* than *too little*;) and with a flat Stick lined with woollen Cloth, firſt rubbing it on your Cheek, or breathing on it, take up your Gold (ſo cut) and put it upon the Size, and the Gold will leave your lined Stick, and cleave to the Size; then *preſs it down* with *Cotton*, or *Hare's Foot*, and take care that you make the Figures, Lines, or Letters, in the *Gold Size*; and that you cut the Gold *large enough* to cover the Figures ſo made in the Size; and when it is *thoroughly dry*, bruſh off the looſe Gold, and the painting will remain beautiful, and be able to endure the Weather.

Note further, That a Book of Gold contains 25 Leaves, each Leaf being three Inches ſquare; the Price of each Book is Two Shillings at the Gold-Beater's; one Book will cover 225 ſquare Inches of Work; for ſo many ſquare Inches are contained in 25 Leaves, that are three Inches ſquare, every Leaf containing nine ſquare Inches ſuperficial in Gold. The right underſtanding of this will much guide you in judging how many Books of Gold will ſerve to gild that Work, whoſe ſuperficial Contents in ſquare Inches may before-hand be known.

To lay on Smalt *to make a* fine Blue.

When you have laid on what you think fit in *Leaf Gold*, take *white Lead*, mix it *pretty ſtiff* with *drying Oil*, and with a Pencil lay that on where you intend your *Blue* ſhall be, and then put your *Smalt* in a *fine Searce*, and ſift it on to the Dial, and with a *Piece of Cotton* dab it down upon the *White* before laid on, and when it is *thoroughly dry*, wipe off all the looſe Colour with a *Feather*, and blow off the Duſt with a *Pair of Bellows*, which will eaſily blow off all, except what fell upon the *White* before laid on to retain the *Blue*, which will be a very beautiful Blue.

Of the Nature *and* Colour *of ſome of the principal Ingredients uſed in painting of Sun Dials.*

1. Ceruse and *White Lead* are the only Colours to be uſed in painting in Oil, and beſides their Uſefulneſs in painting of Dials, Paint made up with them and Oil, is frequently made uſe of in painting Poſts, Paliſadoes, Gates, Doors, Windows, Wainſcoting, &c. and anſwers the End of Painting, both as to Beauty and Preſervation, for they dry well, and ſtrongly reſiſt the Weather; and if you would have them *to dry yet more ſpeedily*, you may in the *tempering* put a little *Oil of Turpentine*, if it be *within Doors*; but *without Doors*, it is better without, becauſe that does not ſo well reſiſt the Weather.

2. *Lamp-Black* is a good Black, if it be firſt burnt, then ground, and laſtly tempered with Oil.

3. *Charcoal* is a Black that will ſerve for ordinary Uſes; it *dries well*, but great Care muſt be taken that it be *well ground*.

4. *Spaniſh Brown*; the beſt is a *deep bright Colour*,

lour, and free from Stones, and being very well ground, is the beſt for priming: It is of a *Horſe Fleſh Colour*, and a *proper Shadow* for *Vermilion.*

5. *Red Lead* is a *great Drier* and *Binder*; for which Reaſon it is made uſe of in the *drying Oil*; it reſiſts the Weather as well as any Colour whatſoever.

6. *Vermilion* is a rich Colour, and of a good Body, but Care muſt be taken that it be finely ground, *even as ſoft as Oil*, and then it will work extraordinary well: It is beſt to buy it *in the Stone*, leſt you meet with ſome that has been *adulterated* with *Red Lead*, or the like; it is a perfect Scarlet of itſelf, and may be altered to ſeveral Varieties, by mixing with other Colours.

7. *Cinnabar Lak* is a *rich Crimſon* Colour, and muſt be very fine ground.

8. *Smalt* is a very *fine Blue*, and it is beſt to *be ſtrewed* on, as before taught; for if you work it *in Oil*, (though you waſh it and mix it with *White Lead)* yet it will *turn black in Time*; if you buy it *to work in Oil*, the *fineſt* is beſt, which is called *Oil-Smalt.*

9. *Blue Bice* is a *pale Colour*, and works well, though a little ſandy.

10. *Blue Verditer* is not ſo good a Blue as *Bice* and *Smalt*, though it may ſerve in Dial-painting, where they are wanting; but it is a little ſandy, and apt to *fade* and *turn greeniſh.*

11. *Indigo* is a very *dark Blue*, and commonly lightened with *White*, when uſed in Painting, except in Shadowing; it grinds fine, and is very proper for the *laſt Colour* of Poſts, Paliſadoes, Doors, Windows, &c. for it reſiſts the Weather, and preſerves the Wood.

12. *Blue Balls* are almoſt like *Indigo*, but not ſo good a Colour, nor will it endure ſo long.

13. *Umber* is a *Hair Colour*, it muſt be very finely ground, which to effect, requires a great deal of Labour; it *dries* and *binds* exceedingly, and is therefore alſo very proper for painting without Doors, as Doors, Palliſadoes; if calcined in a *Crucible*, it is a *natural Shadow* for *Gold*, and ſome other Colours.

14. *Verdigreaſe* is a perfect *willow Green*, but may be altered at Diſcretion, with *Yellow*, &c. but being *very foul*, it muſt be mended or cleanſed, which may be thus done: *Grind it fine, and put to it* eight Times *its Weight of* Spirit of Vinegar, *digeſt till the Vinegar is tinged very green, then decant the Colour; caſt away the Fæces, and* evaporate *the Vinegar in a* Braſs Veſica, *ſo have you a very good Verdigreaſe at the Bottom, much more fine and valuable, then before it was cleanſed*; it dries very ſpeedily.

15. *Yellow Oker*, the *Engliſh*, the Colour of *freſh Wheat Straw*; the foreign is of ſomewhat a *more deep Colour*; it is much uſed in common Painting, being ground very fine.

16. *Yellow Pink* is a *greeniſh Yellow*; it grinds well, and is good to mix with other Colours, to make a *Green*.

Of theſe Colours ſome require *waſhing*, as *Red Lead*, *Blue Bice*, *Smalt*, and *Verditer*, which is thus performed:

Put the Colour into a glazed Veſſel, and put thereto plenty of clear Water; waſh it well, and (after a while) *decant* the Water; repeat this Work *ſix* or *ſeven* Times; at laſt (the Water being but juſt troubled) put it into another glazed Veſſel, leaving the Dregs at the Bottom; then put ſome more Water into this ſecond Veſſel, and waſh it as before, till the Water, after ſettling, be clear, and the Colour remain fine at the Bottom.

Note, Before you take the Colour out of the Veſſel, *ſpread it* about the Sides of the Veſſel *very thin*; and when it is dry, it will Part of it fall down to the Bottom, which keep by itſelf; but that which ſticks to the Sides of the Veſſel is the beſt, and is as fine as any Flower; that ſtrike off with a Feather, and keep it for Uſe.

The Colours that require *waſhing* being thus prepared, (or if they are thoſe that do not require waſhing, they are done without) your next Work is to *grind them*, which is done thus:

Take *a* Spoonful or *two* of the Colour you intend to grind, and put to it a little *linſeed Oil*, (but be careful you put in too little rather than too much;) mix them together, and upon your Stone with a Muller grind them well, adding Oil *by Degrees*, as you ſee it requires it, to make it like an Ointment, (always obſerving that it grinds much better when it is *thick*, than when it is *ſo thin* as to run about the Stone;) every now and then ſcrape it up together with a *thin Knife* or *Lanthorn-horn*, to keep it at or near the Middle of the Stone, and ſo continue to work till you have ground as much as you have Occaſion for; which done, clean your Stone by grinding *Sand* and *Water* upon it, and then waſh and dry it, and the Muller; and when you go to make Uſe of it, mix it with *drying Oil*, till it be ſo thin as to *run freely* from the Pencil, yet ſo thick that the Ground may not *appear through* it, or to *run* when it is laid on, and then it will be the more beautiful Colour, and better endure the Weather.

CHAP.

Note, Dials are not to be refreſhed but by new Painting; yet here take Notice, that I think it not convenient at all to lay new Colouring upon the old Ground of a *Sun Dial*, (that is, to draw the old Lines and Figures over again in the ſame Poſture, wherein they were

CHAP. XXVII. *The Manner of Painting* Timber Work

BY *Timber Work* I mean all Manner of Wainſcot, Doors, Windows, Poſts, Rails, Pails, Gates, Border-boards for Gardens, *&c.* to preſerve them from the Violence of Rain or Injury of the Weather; the Method of doing which, I ſhall here lay down as plain as I can.

Suppoſe then that there be a Set of *Paliſadoes*, or a *Pair of Gates*, or ſome *Poſts* and *Rails* to paint, and I would finiſh them in a *Stone Colour*; firſt look over the Work, and take Notice whether the Joints be open in the Gates, or whether there be any large *Clefts* in the Poſts; for if theſe are not ſecured, *the Wet* will inſinuate itſelf into thoſe Defects, and make the quicker Diſpatch in rotting the whole Work: Let the firſt Buſineſs therefore be to ſtop up theſe

drawn before) but rather to take the Declination a-new, and according thereunto make a *new* Draught of your Dial, and proceed in the painting of it, in all Reſpects, as if it were a new Dial; for it is obſerved, that Dials which were made many Years, as thirty or forty Years ago (which we believe went true when firſt made) will not give the true Hour now, but go very falſe, which is cauſed by ſome ſecret Motion of the Earth, not hitherto taken Notice of, which apparently alters the Declination of all *Planes* whatſoever. If any one requires more Satisfaction herein, let him repair to ſome old Dial that was made many Years ago, and according to the Diſtance of the Subſtile from the Meridian, let him find out the Declination when firſt made, as any Man that is an Artiſt can eaſily do; then let him take the Declination of the Plane by the Sun, and he ſhall find theſe two Declinations to differ conſiderably, according to the Number of Years contained between your Obſervation, and the Time of the Dial's firſt making: So that a Plane that ſtood full South thirty, forty, or ſixty Years ago, ſhall now decline ſome Degrees either to the Eaſt or Weſt, according to the Nature of the Earth's Motion, which is that which is called the *Variation of the Compaſs*, which is found by Obſervation to differ much in the ſame Country, in the Space of fifty or ſixty Years, as all ſkilled in Aſtronomy very well know.

Places ſmooth and even with *Putty*, which is made of Whiting and Linſeed Oil, well beaten together on the grinding Stone, or with a wooden Mallet, to the Conſiſtence of a very ſtiff Dough, and with this let all the Crannies, Clefts, and other Defects be perfectly filled up, that it may be *equal* to the Surface or Outſide of the Stuff; then proceed to the priming of the Work with ſome *Spaniſh Brown* well ground and mixed very thin with Linſeed Oil; with this do over the Work, giving it as much Oil as it will drink up; this in about *two* Days will be indifferently dry: then, if you would do the Work ſubſtantially, do it over again with the ſame priming Colour; when it is thoroughly dry, then take white Lead well ground and tempered up, but not *too thin*, for the *ſtiffer* you work it, if it be not too ſtiff, the better Body will be laid on; and the longer it will laſt: let the Colour be well rubbed on with a large Briſtle Bruſh, and the whole Surface of the Work be ſo entirely covered, that there remain no Crack nor Corner bare, which you may eaſily do by *jobbing* in the Point of a Briſtle Bruſh: Let this firſt Colouring dry, and then go over it a *ſecond Time*, and if you pleaſe a *third* alſo: the Charge will be a little more, but the Advantage will be great in the Duration. This Courſe is ſufficient for any Kind of *Timber Work* that requires only a plain Colour, whether you thus cover the Work with a *Stone Colour*, or elſe with a *Timber Colour* in Umber and White, or a *Lead Colour* with Indigo and White, that with White being cheapeſt of the three by much: nay I have known ſome lay over their Work only with a Coat of *Spaniſh Brown*, by tempering it up more ſtiff than was done for the two firſt Primings, which in ſome Reſpects is cheapeſt of all, and preſerves the Timber perhaps as well as any. Now he that is able to bring the Work thus far on, has proceeded to the higheſt Pitch of that vulgar Painting, that aims at Preſervation beyond Beauty, though ſomething of Beauty is neceſſarily included in this alſo; but this is not all, for he that is arrived thus far, is in a fair Way to other Perfections in the Art of Painting; but for the Painting of *Wainſcot* with its proper Shadows, and for imitating *Olive* and *Walnut Wood*, *Marbles*, and ſuch like, theſe muſt be attained to by ocular Inſpection; it being impoſſible to deliver the Manner of the Operation by Precept without Example; and I am bold to affirm, that a Man ſhall gain more Knowledge by one Day's Experience, than by an Hundred ſpent to acquire it ſome other Way.

I adviſe therefore all thoſe that deſire an Inſight into this Buſineſs, to be a little curious, if Opportunity offers, in obſerving the Manner of a Painter's working, not only in grinding his Colours, but alſo in laying them on, and working in them, in all theſe obſerving the Motion of his Hand, in the manage of any Kind of Tool, and by this Means, with a little imitation joined to the Directions here given, I doubt not but in a ſhort Time you may arrive to great Proficiency in the Buſineſs of vulgar Painting.

Note, That if when you have made uſe of your Colours, there be Occaſion for a ſmall Ceſſation till the Work be finiſhed, in this Caſe it is beſt to cover the Colours, if any remain in your Pots, with *Water*, for that will prevent their *drying*, even in the hotteſt Time.

And for your Pencils, they ought, ſo ſoon as you have done working, to be well waſhed out in clean Linſeed Oil, and then in warm Soap-Suds; for if either Oil or Colours be once dried in the Bruſh or Pencil, it is ſpoiled for ever.

It has been obſerved, that Timber laid over with *White*, when it has ſtood ſome Time in the Weather, the Colour will *crack* and *ſhrink* up together, juſt as Pitch does, if laid on any Thing that ſtands in the Sun; the Cauſe of this is the Colour's being laid on with *too ſtiff a Body*, for being wrought *too thick* once, it will dry with a *Skin on the Outſide*, which will keep the *Inſide* moiſt and prevent its binding firm, from whence thoſe Cracks proceed.

Take notice, that if you ſhall at any Time have occaſion to uſe either Bruſhes that are very ſmall, or Pencils, as in many Caſes there will be occaſion, you ought then to diſpoſe of the Colours you uſe upon a *Pallet*, (which is a wooden Inſtrument eaſy to be had at any *Colour Shop*;) and there work and temper them about with your Pencil, that the Pencil may carry away the more Colour; for *you are to note*, that if a Pencil be only dipt into a Pot of Colour, it brings out no more with it than what hangs on the *Outſide*, and that will work but a little Way, whereas if you rub the Pencil about in the Colour, on a Pallet, a good Quantity of Colour will be taken up in the *Body of the Pencil*; and beſides all this, you may work your Pencils better to a Point on a Pallet, than you can do in a Pot; the Point of a Pencil being of greateſt Uſe in divers Caſes, eſpecially in drawing of Lines, and all kind of Flouriſhing.

I ſhall ſtill be more particular under this Head of Painting, becauſe Painters Work is very expenſive, and is the only Part in Building wherein a Gentleman can be aſſiſting either by himſelf or Servants, it being almoſt impoſſible for any Gentleman to do either Maſons, Bricklayers, Carpenters, or Smith's Works, whereas it is now well known, that ſeveral Noblemen and Gentlemen have by themſelves and Servants painted whole Houſes, without the Aſſiſtance or Direction of a Painter, which when examined by the beſt Judges could not be diſtinguiſhed from the Work of a profeſſed Painter.

And that which conduces moſt to this Practice is the vaſt Diſproportion between the Prices which Painters charge for their Work, and the Expence which Gentlemen are at in this Method of Painting, which at the utmoſt doth not amount to *one fourth* Part of the Painter's Price, to prove which I ſhall ſet down the Prices of Colours, and likewiſe ſhew what *Number of Yards* one Pound of each Colour will paint.

Firſt Primer ground in Oil, at 36*s. per* 112*lb.* weight, or 4*d. per lb.* One Pound of which will paint 20 *ſquare Yards.*

Second Primer ground in Oil, at 36*s. per* 112*lb.* weight, or 4*d. per lb.* One Pound of which will paint 12 *ſquare Yards.*

Beſt White Lead ground in Oil, at 36*s. per* 112*lb.* or 4*d. per lb.* One Pound of which, with two pennyworth of Oil, will paint 8 *ſquare Yards*, which is three Farthings *per* Yard, for which Painters uſually charge 4*d. per* Yard.

1. *Pearl Colour* ground in Oil, at 4*d.* and 5*d. per lb.*
2. *Lead Colour* ground in Oil, at 4*d.* and 5*d. per lb.*
3. *Cream Colour* ground in Oil, at 4*d.* and 5*d. per lb.*
4. *Stone Colour* ground in Oil, at 4*d*, and 5*d. per lb.*
5. *Wainſcot*, or *Oak Colour* ground in Oil, at 4*d.* and 5*d. per lb.*

N. B. *One Pound of any of theſe five Colours, with Oil, will paint eight ſquare Yards, for which Painters uſually charge* 4d. per *Yard.*

1. *Chocolate Colour* ground in Oil, at 6*d. per lb.*
2. *Mahogany Colour* ground in Oil, at 6*d. per lb.*
3. *Cedar Colour* ground in Oil, at 6*d. per lb.*
4. *Walnut-tree Colour* ground in Oil, at 6*d. per lb.*

N.B. *One Pound of any of theſe* four Colours, with *Oil, will paint* 10 *ſquare Yards, for ſome of which Painters uſually charge* 4d. per *Yard, for others more.*

1. *Gold Colour* ground in Oil, at 8*d. per lb.*
2. *Olive Colour* ground in Oil from 8*d.* to 12*d. per lb.*
3. *Pea Colour* ground in Oil from 8*d.* to 12*d. per lb.*
4. Fine *Sky Blue* mixed with *Pruſſian Blue* ground in Oil from 8*d.* to 12*d. per lb.*
5. *Orange Colour* ground in Oil, at 12*d. per lb.*
6. *Lemon Colour* ground in Oil, at 12*d. per lb.*
7. *Straw Colour* ground in Oil, at 12*d per lb.*
8. *Pink Colour* ground in Oil, at 12*d. per lb.*
9. *Bloſſom Colour* ground in Oil at, 12*d. per lb.*

N. B. *One Pound of any of theſe nine Colours, with Oil, will paint eight ſquare Yards, for ſome of which Painters uſually charge* 10d. *or* 12d. per *Yard, for others they will expect more.*

Fine deep Green ground in Oil, at 2*s.* 6*d. per lb.*

N. B. *One Pound of which, with Oil, will paint* 20 *ſquare Yards, for which Painters uſually charge* 12d. *per Yard.*

Oils uſed in Houſe-painting are,

1. *Linſeed Oil*, at 1*d. per* Quart.
2. *Turpentine Oil*, at 12*d. per* Quart.
3. *Beſt drying Oil*, at 12*d. per* Quart.

Painting Bruſhes of ſeveral Sizes from 2*d.*
6*d.* each.

Putty at 4*d. per lb.*

Double Size uſed by the Painters for priming ne
Work at 4*s. per* Firkin, or 2*d. per* Quart.

Single Size at 18*d. per* Firkin, or 1*d. per* Quart.

Theſe Colours, with all other Materials uſed
Painting, are prepared in the beſt Manner, and ſo
by ANDERTON POOLE, Oil and Colourman, th
Corner of *Mark-Lane*, *Tower-Street*, LONDON. H
likewiſe gives printed Directions for the uſing of h
Colours, or procures Painters to work for Gentl-
men by the Day, if required.

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THE GETTY CENT